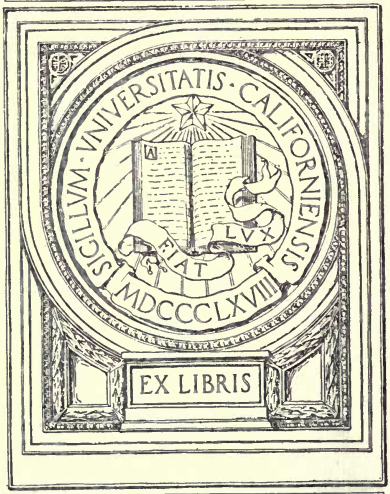

UNIVERSITY OF COLORADO BULLETIN

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BY

JUNIUS HENDERSON

Professor of Natural History and Curator of the Museum

BOULDER, COLORADO, APRIL, 1913

UNIVERSITY EXTENSION DIVISION
General Series No. 7
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You call them thieves and pillagers; but know
They are the winged wardens of your farms,
Who from the cornfields drive the insidious foe,
And from your harvests keep a hundred harms;
Even the blackest of them all, the crow,
Renders good service as your man at arms,
Crushing the beetle in his coat of mail,
And crying havoc on the slug and snail.

—*Longfellow, Birds of Killingworth.*

CONTENTS

THE PRACTICAL VALUE OF BIRDS

The beautiful is as useful as the useful.
—VICTOR HUGO.

Whatever tends to make the world happier and better is of direct material value, though its value may not be measurable in dollars. Every year the people are turning more and more to the study of birds for pleasure. To watch our feathered neighbors, with their bright coats, cheery songs and interesting habits, has become a delight to thousands. Everywhere amateurs may be seen with field-glasses, cameras and note-books in hand, peering into the bushes and treetops in the hope that some new candidate for observation may present itself. "Hunting with a camera," instead of with a gun, has become the slogan in some quarters. Printing presses are kept busy in the publication of books and magazines devoted wholly to ornithology. Ornithologists are flooded with requests for information upon the subject. Boys whose future once looked doubtful have become interested in the protection of birds, thus acquiring new ideas concerning the humane treatment of other living creatures, and are hence destined to better citizenship. So, from moral and aesthetic points of view, as well as for purely utilitarian reasons, general public recognition of the value of birds is important.

Michelet long ago said:

If it were not for the birds no human being could live upon the earth, for the insects upon which birds live would destroy all vegetation.

Very much later a writer in Forest and Stream said:

If the birds were all destroyed agriculture in the United States would instantly cease.

Still later Forbush, one of our foremost writers on this subject, said:

An acquaintance with useful birds of the farm is as important to the farmer as is a knowledge of the insect pests which attack his crops.

Concerning the relation of birds to forests the same writer said:

Were the natural enemies of forest insects annihilated every tree in our woods would be threatened with destruction, and man would be powerless to prevent it.

Such startling assertions are not the vain vaporings of dreamers and sentimentalists. They are the conclusions forced upon scientists by a vast accumulation of information acquired only by the most painstaking and tedious investigation.

Possibly in some instances there has been a tendency toward assertions too extravagant concerning the value of birds. It may be that if birds were all destroyed, the other enemies of destructive insects might be able to take care of the difficulty, but this no one can know. We do definitely know that birds destroy vast hordes of insects every year, and are to be numbered among the most important factors in checking the increase of insects, which, if unchecked by any means, would destroy all vegetation.

THE BALANCE OF NATURE

As naturalists have come to study species more in their relation to and association with each other, they have recognized in Nature a vast system of checks and balances, each species acting as a check upon others, and thus preserving what has become known as the "Balance of Nature." This delicate adjustment is the outcome of ages of evolution. From almost the very

beginning of life upon earth species have been engaged in a constant struggle for existence. In the effort to perpetuate itself, each species is more prolific than would be necessary were there no enemies. So any species in time would populate the whole earth were it not kept in check by its enemies, and having covered the earth, would become so abundant that there would not be food enough for all, hence it would check itself.

Darwin considered this subject in his Origin of Species, especially in the chapter on the "Struggle for Existence." Among many other examples he says the bumble-bee is one of the few, if not the only, insect capable of visiting and pollenizing the red clover; that the number of the bees in any region depends largely upon the number of field mice, as the latter destroy the combs and nests of the bees; that the number of mice depends largely upon the number of cats (he might better have said hawks and owls), because the cats destroy many mice.

> Hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention first of mice and then of bees, the frequency of certain flowers in that district.

Fisher (1) tells of a marsh in New York inhabited by ducks, snapping turtles and other animals. The turtles laid their eggs in the sand, and skunks ate many of the eggs, thus preventing the overabundance of turtles. When skunk fur became valuable, those animals were killed for their fur. Then the turtles multiplied so that their ordinary food was not sufficient, and they began to prey upon the young ducks. Thereupon the ducks deserted the marsh as a nesting place. Finally skunk fur became less valuable and the boys began to catch turtles for the market, thus restoring the equilibrium, and the ducks in time returned to the marsh.

According to Dr. Smith, of the United States Bureau of Fisheries, an alarming scarcity of lobsters on the Breton coast was recently attributed to a scarcity of eels, which usually keep in check the octopus, an active enemy of the lobster (2).

Herons in the South eat many crayfish. Crayfish are said to feed upon fish spawn. Young fish eat mosquito larvæ (3). As the mosquitoes are the hosts of the malaria germ, it is quite conceivable that the destruction of the herons might have a disastrous effect upon the health of the human inhabitants.

These and numerous other instances of similar nature illustrate the danger of unnecessarily disturbing Nature's delicate adjustment, the importance of which is not generally realized. The evolution of species has been in progress for ages, and during all those ages all species have been adjusting themselves to their environment. Birds were already well developed far back in geologic time. The Jurassic Archæopteryx was fully feathered and winged. Hence the preservation of birds is necessary not merely because some species are insectivorous, others engaged in warfare against pernicious rodents, others devoted to the destruction of weed seeds; but also because their unnecessary destruction means a reckless disregard

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(1) Fisher, A. K., The Economic Value of Predaceous Birds and Mammals, U. S. Dept. Agric., Yearbook for 1908, pp. 191-192, 1909.

(2) Nat. Geog. Mag., Vol. XX, p. 553, 1909.

(3) Baynard, Oscar E., Food of Herons and Ibises, Wilson Bulletin, Vol. XXIV, pp. 167-169, 1912.

of Nature's immutable laws and a sad disarrangement of her adjustments, which can only be disastrous.

True, in the rapid settlement of a new country it is impossible to avoid a disturbance of the equilibrium, by destroying breeding places and food supplies of certain species in bringing land under cultivation, and at the same time providing better breeding places and food supplies for other species. This, however, does not excuse unnecessary disturbance of natural conditions by deliberately destroying useful species. It makes it even more imperative that all species not known to be actually harmful be given an opportunity to restore the equilibrium. Much is found in the past history of agriculture in America to indicate that trouble with various pests is likely to immediately follow the extension of agriculture into new regions, but that in time readjustment takes place. It should be our aim to aid, rather than to hinder, Nature in the accomplishment of such readjustment.

It has been urged as an objection to the preservation of birds, that many species of insects are predatory or parasitic; that such species destroy other species of insects, and hence are themselves useful; that birds eat the useful insects, as well as the harmful ones. This same argument applies with equal force to the use of sprays and other artificial methods of keeping insect pests in check. Sprays and fumigants destroy useful as well as harmful species. Beal (4) conclusively answers the argument by pointing out that if, for example, one-half of the individuals of each species of insect were destroyed, it would leave entirely undisturbed the "internal relations of the insects among themselves." In other words, the various species would still bear the same ratio to each other. The preservation of the balance is the service rendered.

The rate of increase of some insects is almost inconceivable. Dr. Murray (5) estimates that the increase from a single house fly, allowing only one out of every 12 eggs to develop would reach the almost incredible number of 7,600,000,000 from April 10 to September 10, only 5 months. Were it not for their active enemies of all kinds, parasitic and predatory, insects would soon increase to such an extent as to be destructive of all vegetation.

The same may be said of pernicious rodents. Field mice have from 6 to 13 young at a time, and from 2 to 6 litters per annum (6). Were it not for the hawks, owls, weasels, snakes and other animals constantly feeding upon them they would soon render agriculture hopeless.

Many species which under normal conditions are useful, or at least harmless, may become very harmful if not kept in check by their enemies. Probably under natural conditions no species is altogether harmful. Fruit trees usually put forth more fruit buds than can mature into choice fruit, and often more foliage than is really advantageous. Insects in reasonable numbers to carry on the work of budding the trees early in the season may in many cases be useful, but if they greatly increase in numbers they would become harmful. When they become too numerous they have been known

(4) Beal, F. E. L., The Relations Between Birds and Insects, U. S. Dept. Agric., Yearbook for 1908, p. 350, 1909. See also Forbes, S. A., Illinois State Lab. Nat. Hist., Bull., Vol. I, No. 3, pp. 90-93.

(5) Popular Mechanics, June, 1912, p. 793.

(6) Piper, Stanley E., The Nevada Mouse Plague of 1907-8, U. S. Dept. Agric., Farmers' Bull. No. 352, 1909; Mouse Plagues, Their Control and Prevention, U. S. Dept. Agric., Yearbook for 1908, p. 303, 1909.

to attract many species of birds which are looking for a plentiful food supply, this acting as a check upon the insects. The setting out of large orchards affords an immediate opportunity for a great increase in insect pests, by furnishing them both food and breeding places, while the birds which feed largely upon the insects increase very much more slowly. Thus the natural adjustment of species is disturbed, and it then may require many years to restore the equilibrium.

> The true function of insectivorous birds is not so much to destroy this or that insect pest as it is to lessen the numbers of the insect tribe as a whole—to reduce to a lower level the great food tide of insect life. That this is the true relation of birds and insects would be inferred from the fact that the two have lived together for countless ages, and the balance of nature has been preserved except as disturbed by the operations of man. Birds have not wholly destroyed predaceous and parasitic insects on the one hand, nor on the other have they, so far as we know, exterminated any vegetable-eating pest, but they have successfully held the balance between the two, and kept both at such a level of relative abundance as has subserved the best interests of both the animal and the vegetable world; and it is only where man has interfered with this balance that oscillations have taken place which have resulted in damage to him and to the products of his labor (7).

Because of the fact that some species of insects and other pests which are normally kept within reasonable bounds, may, during especially favorable seasons or cycles of seasons increase so rapidly as to become very harmful, those birds which take a mixed diet are particularly valuable. Thus a bird species which ordinarily is largely vegetarian lives through seasons of scarcity of insects, and then is ready to turn its attention to an insect diet whenever the insects become overabundant; whereas, if the birds were all exclusively insectivorous, comparatively few would survive seasons unfavorable to insects and thus be on hand to aid in the warfare against those pests when seasons favorable to insect life occur.

A species which is harmless, or even beneficial, in its natural habitat, may become injurious when transported to a new environment, where the natural checks upon its increase are wanting, or the lack of its natural food, or the presence of a food which is more enjoyable, may cause a marked change in its food habits. It is said that the skylark, green linnet and black thrush are considered beneficial in Europe, where they are native, but in New Zealand, into which country they have been introduced, "they have developed traits which render them far from desirable additions to the fauna of that island"(8). It will be interesting to watch the effect of the introduction of the Little Gray Owl into New Zealand for the purpose of fighting the English sparrow (9). Such importations are now, as a result of disastrous experience, prohibited by law in some countries, including the United States.

The introduction of a species may disturb the balance as much as the extermination of one. European rats, accidentally introduced into Jamaica, became a great nuisance. The Indian mongoose was imported to destroy the rats. It turned its attention to game birds, poultry, young pigs and lambs, and became a great pest, also destroying many birds, snakes and lizards, which feed largely upon insects. This was followed by an increase of insect pests. Disaster also followed the introduction of the mongoose into Hawaii, and its importation into the United States was barely prevented. Rabbits,

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(7) Beal, F. E. L., The Relations Between Birds and Insects, U. S. Dept. Agric., Yearbook for 1908, pp. 347-348, 1909.

(8) Palmer, T. S., The Danger of Introducing Noxious Animals and Birds, U. S. Dept. Agric., Yearbook for 1898, p. 106, 1899.

(9) Drummond, Jas., Introduced Birds of New Zealand, The Condor, Vol. XIV, p. 227, 1912.

introduced into Australia for purposes of sport, in the absence of predatory animals, spread over the whole country like a scourge, and immense sums have been expended in the effort to check their depredations. In New Zealand, ferrets, stoats and weasels were imported to destroy the rabbits, and as a result some of the native birds are threatened with extermination (10). The introduction of the English Sparrow into the United States, the consequent decrease in the number of insectivorous birds and the increase of such pests as the hairy caterpillars, is too well known to need discussion (11).

RESCUE OF CROPS, FOLIAGE AND FORESTS BY BIRDS

Birds which ordinarily take small numbers of insects, take them in much larger quantities when they are abundant. This fact and the ease with which birds pass from one locality to another in search of food, have often saved crops from destruction. A few instances chosen at random from many will illustrate this.

When the myriads of crickets threatened the crops of early settlers at Salt Lake, Utah, California gulls arrived "by hundreds and thousands," and saved the crops (12). California orchard crops have several times been saved from outbreaks of the canker worm by Brewer's blackbirds, which flocked to the rescue, and, working from tree to tree, completely cleaned them out (13), and the same well-known bird of the West saved the foliage in northern California from a plague of caterpillars (14). A canker worm outbreak in a Massachusetts orchard was checked by a large flock of cedar waxwings, which also cleaned the elm trees of their greatest foe, the elm-leaf beetle (15).

The destruction of hawks and owls, which prey extensively upon field mice, has been followed by plagues of these destructive rodents, and unusual abundance of the mice in various parts of the world has frequently attracted large numbers of predatory birds to feed upon them, including hawks, owls, gulls, storks, spoonbills, cranes, herons, crows, ravens, magpies, jays, etc. (16).

Forbes collected a large number of robins, catbirds, dickcissels and indigo buntings in a canker-infested orchard, and other specimens of the same species elsewhere, and compared the contents of their stomachs. He found in every instance that the caterpillar element of food of those collected in

(10) Palmer, *op. cit., pp.* 87-100.

(11) Palmer, *op. cit.* Barrows, Walter B., *et al.*, The English Sparrow (*Passer domesticus*) in North America, Especially in its Relation to Agriculture, U. S. Dept. Agric., Div. Econ. Orn. & Mam., Bull. No. 1, 1889. See especially pp. 107 and 122.

(12) McAtee, W. L., and Beal, F. E. L., Some Common Game, Aquatic and Rapacious Birds in Relation to Man, U. S. Dept. Agric., Farmers' Bull. No. 497, pp. 21-22, 1912.

(13) Beal, F. E. L., The Relations Between Birds and Insects, U. S. Dept. Agric., Yearbook for 1908, p. 345, 1909; U. S. Biol. Surv., Bull. No. 34, p. 60.

(14) Bryant, Harold C., The Relation of Birds to an Insect Outbreak in Northern California During the Spring and Summer of 1911, The Condor, Vol. XIII, pp. 195-208, 1911.

(15) Forbush, E. H., Fourth Ann. Rept. Mass. State Ornithologist, pp. 19-21, 1912.

(16) Beal, F. E. L., How Birds Affect the Orchard, U. S. Dept. Agric., Yearbook for 1900, p. 300, 1901. Fisher, A. K., Hawks and Owls from the Standpoint of the Farmer, Yearbook for 1894, pp. 219, 224-225, 1894, (revised and published as U. S. Biol. Surv. Circ. No. 61, 1907). Lantz, David E., An Economic Study of Field Mice, U. S. Biol. Surv., Bull. No. 31, pp. 47-48, 52-53. Piper, Stanley E., Mouse Plagues, Their Control and Prevention, Yearbook for 1908, pp. 303-309, 1909.

the orchard was, on account of the abundance of canker worms and cutworms, very much greater than in those collected elsewhere (17). The respective percentages of caterpillars are as follows:

	Specimens from orchard.	Specimens from elsewhere.
Robin	54%	23%
Catbird	26%	12%
Dickcissel	88%	47%
Indigo Bunting	29%	19%

Thirty-six species of birds are known to feed upon the larvæ of the codling moth, whose ravages are often so disastrous to orchard crops. Many other species doubtless take this pest. It is estimated that the birds destroy from 66% to 85% of the larvæ (18) in some localities.

On the other hand, certain species of birds may themselves, under some circumstances, become harmful. The failure of a natural food supply may drive birds to cultivated crops. This is believed to be the cause of the raid upon olive groves by robins in California, in 1900-1901 (19). Blackbirds sometimes accumulate in such numbers as to damage crops, though under normal conditions they are much more beneficial than harmful. Bobolinks inflict great damage upon the rice crops, when they accumulate in vast flocks in the South. The species which are occasionally harmful locally, during most of the time are useful, and, by their occurrence in large numbers when insect pests are overabundant, often actually save crops from destruction.

When an insect or rodent pest has gotten beyond control, the birds cannot, of course, in many instances, immediately restore the balance, so that usually artificial means must be adopted to save the crops. Although they are often able, unaided, to reduce pests in small areas and thus save crops from great uprisings of insect or rodent pests, and in many other cases to greatly aid the agriculturist in combating such uprisings, yet their greatest value is their continuous work in preventing such uprisings.

According to Forbes (20) it is estimated that in Illinois the birds destroy about 70% of the insects, which, though it would not exterminate the insects, certainly must act as a very efficient check upon their undue increase usually.

The number of species and subspecies of birds in the various states of the Union varies from about 325 to 530, the latter number being credited to California, where many local races are found. Colorado claims 403 (21). So varied are their habits that scarcely a pest of any kind can escape their attention. Swallows, martins and nighthawks may be seen wheeling and zig-

(17) Forbes, S. A., The Regulative Action of Birds upon Insect Oscillations, Illinois State Lab. Nat. Hist., Bull., Vol. I, No. 3, pp. 3-32.

(18) McAtee, W. L., Bird Enemies of the Codling Moth, U. S. Dept. Agric., Yearbook for 1911, pp. 243-245, 1912.

(19) Beal, F. E. L., The Relation of Birds to Fruit Growing in California, U. S. Dept. Agric., Yearbook for 1904, pp. 242, 252-253, 1905; Birds of California in Relation to the Fruit Industry, U. S. Biol. Surv., Bull. No. 30, p. 9, 1907.

(20) Forbes, S. A., The Food of Birds, Illinois State Lab. Nat. Hist., Bull., Vol. I, No. 3, pp. 86-87.

(21) Cooke, W. W., The Condor, Vol. XIV, pp. 151-152, 1912.

zagging through the air, gathering in flying insects on the wing. Flycatchers watch for flying insects from high perches. Towhees, under the bushes, find the lowly creatures which creep about on the ground and would thus escape the observation of the swallows. Chickadees, tits, nuthatches, kinglets, warblers and wrens search the bark and leaves of trees and shrubbery. Some favor the lower branches, others prefer the topmost limbs, others indifferently search the trees from roots to top, scanning every nook and crevice for the small insects which would escape the attention of larger birds, but which are so destructive, including scale insects, plant lice, and innumerable insect eggs. Hawks and owls hover over fields, orchards, forests and meadows, watching for luckless mice, squirrels, rabbits and other destructive rodents, which girdle trees and destroy grain. Finches and sparrows haunt weed patches during the winter, consuming almost incredible numbers of weed seeds, then in summer catch insects for themselves and their young. Woodpeckers destroy the larvæ of wood-boring insects, which cannot well be reached by other birds. The good work goes on from the first peep of dawn until late twilight, the owls even working on night shift. Some species are with us the year round, others remain only through the summer, while others come in from the north in the winter. Many species which are not highly insectivorous as adults, feed their young almost entirely upon the soft-bodied insects during the first few days of their existence.

In August, when grasshoppers are abundant, they form a very large element in the food of many species, even including some of the large hawks. Aughey's (22) report upon birds of Nebraska in relation to the Rocky Mountain locust, which was such a scourge from 35 to 45 years ago, is a classic. He definitely reports 202 species of birds found feeding upon the locusts and their eggs, including even water birds. About half of these records were based upon actual count of the grasshoppers in the stomachs. A very large percentage of the stomachs contained over 25 locusts and a considerable number contained over 60. Many other species are now known to take locusts and grasshoppers. As Aughey's report has long been out of print, is inaccessible to most students, and the relation of birds to locust and grasshopper outbreaks in the West is an important matter, the following summary of his data has been tabulated, giving average numbers of Rocky Mountain locusts in the stomachs of the various species (including in a few instances other members of the grasshopper family), the average number of other insects, besides other food, the x being used where the actual number is not designated, and in a few cases percentages being indicated, instead of actual numbers:

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(22) Aughey, Samuel, Notes on the Nature of the Food of the Birds of Nebraska, First Ann. Rept. U. S. Entom. Comm., for the year 1877, Relating to the Rocky Mountain Locust, Appendix II, pp. 13-62, 1878. Reprinted as Unclassified Pub. No. 14, U. S. Geol. & Geog. Surv. Terr. (Hayden Survey).

SPECIES OF BIRDS.	Number of stomachs examined	Average number of locusts	Average number of other insects	Seen eating locusts	Average number of seeds and grains	OTHER FOOD.
Eared Grebe	2	7	x		x	Crayfish, fish.
Pomarine Jaeger	1	few				Crayfish, frogs, fish.
Great Black-backed Gull	1	few	x			Fish, frogs.
Herring Gull	2	6				Fish, mollusks.
Ring-billed Gull	6	6	14			Fish, frogs, mollusks, etc.
Franklin's Gull	10	21	11			Crayfish, vertebrates.
Forster's Tern	2	8				Crayfish, fish, lizard.
Least Tern	8	19	15			Crayfish, etc., vertebrates.
Black Tern	6	38	15			Crayfish, etc., vertebrates.
White Pelican	5	2 1	19			Crayfish, fish, frogs.
Mallard	10	22	26			Mollusks, etc.
Black Duck	1	16	30		x	Grass.
Green-winged Teal	9	5	38			Mollusks, etc.
Blue-winged Teal	1	37	22		x	Mollusks,
Shoveller	1	32	28		x	Mollusks,
Pintail	7	11	34			Mollusks, etc.
Wood Duck	9	15	23			Mollusks, etc.
Bufflehead	4	10	22		x	Mollusks.
Ruddy Duck	1	31	20			Mollusks.
Lesser Snow Goose	8	30	33			Mollusks, grass.
Canada Goose	9	31	42			Mollusks, grass.
Bittern	1	16				
Great Blue Heron	1	11				Fish, frogs.
Sandhill Crane	4	66	50		x	
King Rail	7	33	30		x	
Little Black Rail	1	11	27		x	
Florida Gallinule	1	7	29		x	
Coot	9	23	29			Mollusks.
Wilson's Phalarope	8		56			
Avocet	2	50%	50%			
Woodcock	1	32	x			
Wilson, Snipe	11	38	23			
Dowitcher	6	5	54			
Knot	1	11	many			
Baird's Sandpiper	5	9	34			
Least Sandpiper	8	18	26			
Semipalmated Sandpiper	2		x			
Marbled Godwit	6	7	36			
Greater Yellowlegs	6		50			
Yellowlegs	5	12	31			
Solitary Sandpiper	2	5	38			
Bartramian Sandpiper	22	37	16			
Buff-breasted Sandpiper	1	42	few			
Spotted Sandpiper	6	15	23			
Long-billed Curlew	10	48	15		12	
Eskimo Curlew	1	31				Many berries.
Black bellied Plover	2	full	few			
Golden Plover	4	many	many			
Killdeer	9	29	21		few	
Semipalmated Plover	11	38	19			
Belted Piping Plover	4	26	32			
Mountain Plover	16	47	13			
Bob-white	21	25	14		x	
Prairie Hen	21	41	10		x	
Prairie Sharp-tailed Grouse	10	17	9		x	
Sage Grouse	4	47	3			Sage leaves.
Wild Turkey	6	43	18		23	
Passenger Pigeon	6	8	2		x	
Mourning Dove	6	1	3		57	
Swallow-tailed Kite	3	43	27			
Marsh Hawk	6	41	26			Gopher, rentiles.
Cooper's Hawk	6	few				Mammal, birds.
Goshawk	1	few				Rabbit, quail.
Red-tailed Hawk	1		37			Quail.
Swainson's Hawk	4	33	31			Mammals.
Rough-legged Hawk	1		70			Gopher, lizard.
Prairie Falcon	1	16				Bird.
Pigeon Hawk	6	few				Birds.
Richardson's Merlin	2		12			Birds.
Sparrow Hawk	10	5	31			Vertebrates.

SPECIES OF BIRDS.	Number of stomachs examined	Average number of locusts	Average number of other insects	Seen eating locusts	Average number of seeds and grains	OTHER FOOD.
Barn Owl	3	13	39			Mice.
Long-eared Owl	1		few			Rabbit.
Short-eared Owl	2	15	8			Rabbit, gopher.
Barred Owl				x		
Screech Owl	8	27	27			Bird, mice.
Great Horned Owl	1		30			Gopher.
Snowy Owl	4	2				Birds, mammals.
Burrowing Owl	9	34	23			Vertebrates.
Yellow-billed Cuckoo	10	41	15			
Black-billed Cuckoo	1	41				
Belted Kingfisher	2	16				Fish.
Hairy Woodpecker	6	26	32			
Downy Woodpecker	4	41	20			
Yellow-bellied Sapsucker	5	26	17			
Red-headed Woodpecker	6	25	35		7	
Red-bellied Woodpecker	2	50%	50%			
Northern Flicker	8	29	25		4	
Red-shafted Flicker	1	18	31			
Whip-poor-will	2	full				
Poor-will	1	80%				
Nighthawk	7	51	12			
Chimney Swift	x	x	x			
Ruby-throated Hummingbird	1	4				
Kingbird	8	27	32		few	
Arkansas Kingbird				x		
Crested Flycatcher	1	23	58			
Phœbe	9	23	21		few	
Say's Phœbe	1	32				
Olive-sided Flycatcher	1	17	x			
Wood Pewee	1	7	many			
Western Wood Pewee	1	22				
Yellow-bellied Flycatcher	1	16	x			
Least Flycatcher	4	10	15			
Horned Lark	1	42			33	
Magpie	1	1	x			
Blue Jay	1	45			x	
Raven	1	12	many		x	
Crow	x	x	x			
Clarke's Crow (Nutcracker)	1	41			x	
Bobolink	6	7	9		many	
Cowbird	x		x	x		
Yellow-headed Blackbird	20	7	37		19	
Red-winged Blackbird	x		x	x	x	
Meadowlark	9	23	8		many	
Orchard Oriole	2	75%				
Baltimore Oriole				x		
Bullock's Oriole	1	35	3		x	
Rusty Grackle	x	80%	x		few	
Brewer's Blackbird	x	75%	x		few	
Purple Grackle	x	many	x			
Evening Grosbeak	1	2			many	
Pine Grosbeak	5	eggs			x	
Purple Finch	1	eggs				
Gray-crowned Leucosticte	2	1			many	
Red-poll	4	eggs			many	
Goldfinch	3	8				
Snowflake	6	eggs				
Lapland Longspur	5	eggs			many	
Chestnut-collared Longspur	6	14			many	
McCown's Longspur	2	5	1			
Vesper Sparrow	5	13			x	
Grasshopper Sparrow	7	7	x		x	
Henslow's Sparrow	1	13	x		many	
Lark Sparrow	6	15	11		many	
Harris' Sparrow	1	14	5		many	
White-crowned Sparrow	1	11	x			
White-throated Sparrow	5	20	14			
Tree Sparrow	1	13	1		many	

SPECIES OF BIRDS.	Number of stomachs examined	Average number of locusts	Average number of other insects	Seen eating locusts	Average number of seeds and grains	OTHER FOOD.
Chipping Sparrow	x	few				
Clay-colored Sparrow	1	9			many	
Slate-colored Junco	1	14	1		many	
Song Sparrow	2	6	8			
Lincoln's Sparrow	1	11	3			
Towhee	3	11	few		many	
Cardinal	4	12	10			
Rose-breasted Grosbeak	2	12				
Black-headed Grosbeak	2	12			many	
Blue Grosbeak	1	3	12		many	
Indigo Bunting	2	5	4		many	
Dickcissel	5	21	7		many	
Lark Bunting	9	14				
Western Tanager	1	13	many			
Scarlet Tanager	1	37				
Purple Martin	10	26	16			
Cliff Swallow	8	30	14			
Barn Swallow	7	20	19			
Violet-Green Swallow	1	23	17			
Bank Swallow	5	20	21			
Bohemian Waxwing	1	eggs				
Cedar Waxwing	1	17			many	
Northern Shrike	1	14		x		
White-rumped Shrike	3	32				Birds.
Red-eyed Vireo	x	many				
Philadelphia Vireo	4	11	16			
Warbling Vireo				x		
Blue-headed Vireo	1	50%	50%			
White-eyed Vireo				x		
Black and White Warbler	1	41	12		few	
Prothonotary Warbler				x		
Worm-eating Warbler				x		
Blue-winged Warbler				x		
Nashville Warbler	1	21	few	x		
Tennessee Warbler				x		
Parula Warbler				x		
Yellow Warbler	7	11	25			
Black-throated Blue Warbler	1	23	15			
Myrtle Warbler	1	31	5	x		
Magnolia Warbler	1	23	17			
Cerulean Warbler				x		
Chestnut-sided Warbler	1	17	21			
Bay-breasted Warbler	1	19	22			
Black-poll Warbler	4	30	12			
Yellow-throated Warbler	1	15	24			
Black-throated green Warbler	5	25	21			
Pine Warbler	4	11				Locust Eggs.
Palm Warbler	2	16	few			Locust Eggs.
Prairie Warbler	8	14	17			
Ovenbird	6	18	15			Locust Eggs.
Waterthrush	1	19	30			
Louisiana Waterthrush	1	13	37			
Kentucky Warbler	1	9	many			
Macgillivray's Warbler				x		
Maryland Yellowthroat	1	8		x		
Yellow-breasted Chat				x		
Hooded Warbler				x		
Wilson's Warbler				x		
Canadian Warbler	1	5	29			
Redstart	7	23	16			
Pipit	3	47	4		few	
Mockingbird				x		
Catbird	5	30	10			
Brown Thrasher				x		
Rock Wren				x		
Carolina Wren				x		
Bewick's Wren				x		
House Wren				x		

SPECIES OF BIRDS.	Number of stomachs examined	Average number of locusts	Average number of other insects	Seen eating locusts	Average number of seeds and grains	OTHER FOOD.
Western House Wren.....				x		
Winter Wren	1	13				
Long-billed Marsh Wren....				x		
Brown Creeper				x		
Slender-billed Nuthatch	4	23	4		4	
Red-breasted Nuthatch				x		
Tufted Titmouse	4	65	4		few	
Plain Titmouse				x		
Long-tailed Chickadee	9	53	6			
Golden-crowned Kinglet				x		
Ruby-crowned Kinglet	1	29	x			
Blue-gray Gnatcatcher				x		
Townsend's Solitaire				x		
Wood Thrush	3	22	4			
Wilson's Thrush	2	36	29			
Olive-backed Thrush	2	27	12			
Hermit Thrush	1	19	16			
Robin	6	45	14		2	
Bluebird	3	22	6			
Mountain Bluebird				x		

Judd (23) reports the following percentages of grasshoppers in the summer stomachs of 7 members of the finch family, which are not generally supposed to be especially insectivorous: Dickcissel 41%, grasshopper sparrow 37%, lark sparrow 31%, vesper sparrow 23%, chipping sparrow 21%, song sparrow 17%, field sparrow 13%. In a recent grasshopper outbreak in California, Bryant examined 17 species of birds, and found grasshoppers in the stomachs of all except 3, constituting from 2% to 100% of their food, as follows (24): Killdeer 100%, Anthony's green heron 15%, burrowing owl 90%, western kingbird 67.5%, black phœbe 50%, California horned lark 7.5%, bicolored blackbird 81.2%, tricolored blackbird 97%, western meadowlark 96.2%, Bullock's oriole 92%, Brewer's blackbird 80%, English sparrow 2%, California shrike 47%.

Four thousand stomachs of native sparrows and finches show that during the colder half of the year their food consists almost entirely of weed seeds (25). In a garden within 2 months they will sometimes destroy 90% of such seeds as pigeon-grass and ragweed (26). Many birds besides finches indulge largely in seed-eating. Judd (27) found that weed seeds constituted 18% of the total food of all birds collected on a Maryland farm, and that the seeds were taken by 20 of the species on the farm.

(23) Judd, Sylvester D., The Relation of Sparrows to Agriculture, U. S. Dept. Agric., Biol. Surv., Bull. No. 15, p. 62, 1901.

(24) Bryant, Harold C., Birds in Relation to a Grasshopper Outbreak in California, Univ. Cali. Pub. in Zool., Vol. XI, No. 1, p. 9, 1912.

(25) Judd, Sylvester D., Birds as Weed Destroyers, U. S. Dept. Agric., Yearbook for 1898, p. 223.

(26) Judd, Sylvester D., U. S. Biol. Surv., Bull. 15, p. 29.

(27) Judd, Sylvester D., Birds of a Maryland Farm, U. S. Dept. Agric., Biol. Surv., Bull. 17, pp. 70-71.

QUANTITIES OF FOOD REQUIRED BY BIRDS

In order to fully comprehend the significance of food percentages in discussing birds, it is quite necessary to understand that they require a much larger amount of food in proportion to their weight than do any other vertebrate animals, for several reasons. (a) Their temperature and rate of respiration are much higher than in case of mammals, the only other group of "warm-blooded" animals. A drop of a few degrees in the blood temperature of a warm-blooded animal, except in case of hibernation, is fatal. Food is the fuel which maintains that high temperature. (b) The adults are vastly more active than other vertebrates. The prodigious energy displayed by the buzzing of the wings of a hummingbird as it hovers over a flower, the great distances traversed in an evening by a nighthawk as it circles in search of insects, the tremendous speed maintained by a teal duck for long periods, grade through various species down to the more moderate movements of the sparrows; but even the most sluggish is very much more active than any member of any other group of vertebrates. This is especially true when they are feeding their young, and so must gather in some instances many times as much food as the parents themselves require. During this season their activity continues almost throughout the day, from dawn until dark. Food furnishes the motive power for this great and ceaseless activity. (c) What the nestlings lack in activity is more than made up in rapidity of growth. The number of broods of young varies with different species, but probably averages 2 or 3 broods of from 3 to 5 young each per annum, which require constant feeding. At first the nestlings of most species consume more than their own weight of food in a day (with most species chiefly soft-bodied insects), and gain in weight at the rate of from 20% to 60% daily (28), usually reaching adult weight in from 4 to 5 weeks. Only large quantities of easily digested food could produce such a rate of growth.

Birds with crops fill both crops and stomachs with food about twice a day. Probably insectivorous birds fill their stomachs on an average about 5 or 6 times a day (29). Hence the amount of food found in a bird's stomach represents in one case about half, and in the other only one-fifth or one-sixth of the food taken in a day. Experiments show that it requires from 3 to 4 hours for young meadowlarks to digest grasshoppers, which means at least 3 or 4 meals per day (30). On the other hand, of course, grain is digested more slowly, the inactive, grain-eating poultry in confinement, requiring from 12 to 24 hours (31). A shrike in captivity, when fed on May-

(28) Judd, Sylvester D., The Food of Nestling Birds, U. S. Dept. Agric., Yearbook for 1900, pp. 411, 435-436. Bergtold, W. H., A Study of the House Finch, The Auk, Vol. XXX, pp. 64-68, 1913. Sherman, Althea R., At the Sign of the Northern Flicker, The Wilson Bulletin, Nos. 72-73, Vol. XXII, pp. 169-171, 1910.

(29) Bailey, Vernon, Birds Known to Eat the Boll Weevil. U. S. Dept. Agric., Biol. Surv., Bull. No. 22, p. 15.

(30) Bryant, Harold D., The Numbers of Insects Destroyed by Western Meadowlarks, Science, n. s. Vol. XXXVI, p. 874, 1912. See also Univ. Call. Pub. in Zool., Vol. XI, p. 7.

(31) Brown, E. W., Digestion Experiments with Poultry, U. S. Dept. Agric., Bureau of Animal Industry, Bull. No. 56, pp. 77-78, 1904.

beetles, disgorged the waste in 1 hour and 20 minutes, and when fed on a mouse digestion required 3 hours (32).

A young robin in captivity ate from 50 to 70 cutworms and earthworms daily from May 21 to June 6, and on June 9, when the bird weighed exactly 3 ounces, it consumed 165 cutworms, which weighed altogether 5½ ounces, nearly twice the weight of the bird (33). Another robin on the 14th day of its life ate 68 worms, which weighed 41% more than the bird (34).

One snowy owl contained 14 white-footed mice and 3 meadow mice (35). A golden eagle in captivity will consume 2 pounds of fresh meat daily (36). A Cooper's hawk reared by Judd (37) frequently ate its own weight of food in a day, and another, 6 weeks old, was observed by Roddy to devour 8 English sparrows and a mouse in one day. One flicker stomach contained 5,040 ants and 2 others contained about 3,000 each (38). One quail stomach contained 10,000 pigweed seeds, another contained 5,000 pigeon-grass seeds (39).

A given number of thousands of insects or seeds taken by a bird in a week does not mean merely the destruction of so many insects or seeds, but that those thousands and other thousands taken from week to week are prevented from reproducing their kind and so multiplying by millions far into the future. Likewise the destruction of a useful bird does not mean merely one useful bird removed, but means the destruction of all possible progeny of that bird.

The various so-called protective devices of insects, such as concealing coloration, defensive armor and offensive secretions, are unavailing as a means of escaping their sharp-eyed enemies, the birds (40).

METHODS OF INVESTIGATION

The primitive method of investigating the food habits of birds was field observation. While that method brought forth considerable accurate information, yet in many cases it inevitably led to incorrect conclusions. If hawks were frequently seen to carry off chickens it would naturally lead to the destruction of all hawks, without discrimination as to species. In fact, the large hawks commonly called "chicken hawks" are not the chicken hawks at all. If blackbirds were seen digging about the roots of sprouting corn, it would naturally be inferred, and perhaps even demonstrated, that

(32) Judd, Sylvester D., Birds of a Maryland Farm, U. S. Biol. Surv., Bull. No. 17, p. 102.

(33) Nash, Charles W., The Birds of Ontario in Relation to Agriculture, Ontario Dept. Agric., 1898, p. 22.

(34) Palmer, T. S., A Review of Economic Ornithology in the United States, U. S. Dept. Agric., Yearbook for 1899, pp. 261-262, citing Treadwell, Proc. Boston Soc. Nat. Hist., Vol. VI, pp. 386-399, 1859.

(35) Fisher, A. K., Hawks and Owls from the Standpoint of the Farmer, U. S. Dept. Agric., Yearbook for 1894, p. 226; Hawks and Owls of the United States in their Relation to Agriculture, U. S. Dept. Agric., Div. Orn. and Mam., Bull. No. 3, p. 187, 1893.

(36) Oberholser, Harry C., The North American Eagles and their Economic Relations, U. S. Dept. Agric., Biol. Surv., Bull. No. 27, p. 30.

(37) Judd, Sylvester D., The Food of Nestling Birds, U. S. Dept. Agric., Yearbook for 1900, p. 429, citing Roddy, The Auk, Vol. V, p. 246.

(38) Beal, F. E. L., Food of the Woodpeckers of the United States, U. S. Dept. Agric., Biol. Surv., Bull. No. 37, p. 54.

(39) Judd, Sylvester D., The Economic Value of the Bobwhite, U. S. Dept. Agric., Yearbook for 1903, p. 195.

(40) Beal, Agric. Yearbook for 1908, pp. 346-347.

they were, at least to some extent, feeding upon the corn, but field observation alone could not inform the observer of the proportion of cutworms and other pests taken to pay for the corn. If the robins were seen picking cherries, it was easy to infer that their food is cherries, with no knowledge of the fact that to some extent they made the cherries possible by their police work in the prevention of the ravages of insects.

From innumerable observations of many species, naturalists are able to tell much about the food habits of a given species by its physical structure. The long legs, long neck and spear-like beak of the heron family are correlated with the food habits of the family. So, too, the ducks have feet and bills suited to their feeding habits. The cracking of weed seeds, so easy for the finches, with their stout, conical bills, would be quite impossible for the warblers, yet people who suppose the yellow warblers to be wild canaries attempt to feed them with bird seeds such as are placed in the canary cages. The woodpecker easily sinks a shaft to the tunnel of a tree-boring insect and extracts the dainty morsel for his breakfast, while a dove would have a sad time trying to get the troublesome borer.

But after all, the final test is an examination of the actual contents of the stomachs. From a decision based upon such evidence, providing a sufficient number of stomachs are examined with care, there is no appeal. It has often been asserted that certain insects are not taken by birds because they are concealingly colored and escape observation; that others are not taken because they are protected by bristles or other armor; that others, such as blister beetles and stink bugs, are not taken because they possess irritating or nauseating secretions; but actual examination of the stomach contents of birds has shown conclusively that all these types of insects are taken regularly and in fair quantities by some species of birds.

In the literature of economic ornithology it is customary, for the sake of convenience, to include under the term stomach, the crop (of such species as have crops), the throat, etc. In case of many insects, even small fragments of the hard parts remaining after the soft parts have been digested, may be identified. The work of sorting over miscellaneous material and identifying it, often under a lens or even with the aid of a compound microscope, is extremely tedious. The United States Biological Survey, a bureau or division of the Department of Agriculture, has been preeminent in this work, as may be seen by a glance at the bibliography accompanying this paper, though there have been and now are a number of independent workers of note in this field of study. With no actual figures of recent date at hand, it is safe to say that probably between 50,000 and 100,000 bird stomachs have been examined in the United States alone (41).

The net result of all this work is to convince naturalists that nearly all native species of birds should be protected.

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(41) McAtee, W. L., Methods of Estimating the Contents of Bird Stomachs, The Auk, Vol. XXIX, pp. 449-464, 1912.

NECESSITY OF BIRD PROTECTION

It having been demonstrated to the satisfaction of naturalists that nearly all native species of birds are useful, and many of them vitally useful, to man, the need of protective legislation and a healthy public sentiment in favor of the preservation of birds is apparent from a consideration of the facts. During all except the last decades of the past century the destruction of birds was going on in the United States and elsewhere at an appalling rate. During the last two decades the destruction has been in a large measure checked in most parts of the United States, owing to legislation, and more particularly, perhaps, to the educational work carried on by various agricultural, horticultural, and ornithological societies, and the widespread dissemination of literature bearing upon the subject by the United States Department of Agriculture.

Fifteen years ago the New York Zoological Society, in cooperation with ornithologists throughout the United States, conducted an investigation of the decrease of bird life in the United States. The report (42) shows an average decrease of 46% in the number of birds in 30 states, an increase in 4, and increase and decrease balanced in 3. As the eggs average probably not more than 4 to a clutch, and not more than half of them ever develop birds to maturity, such destruction cannot easily be replaced, as it would be in case of insects.

Every sportsman and naturalist is familiar with the decrease in game birds. The disgraceful extermination of the passenger pigeon in the United States is being repeated in case of some other species. These pigeons were formerly found in almost incredible flocks, but now there is not supposed to be one left alive in the wild state, and at last account but one in captivity (43). The offer of large rewards (44) in 1910, 1911 and 1912 has failed to bring any information of a single wild bird of this species now living. They were killed at their "roosts," not by hundreds or thousands, but by tons, for the market. Audubon tells of seeing schooners at the New York wharves loaded in bulk with the pigeons at 1 cent each, in 1805, and Roney estimated that in 1878 1,500,000 dead birds and 80,532 live ones were shipped from near Petosky, Michigan (45). No one who reads the numerous accounts of the ruthless slaughter need wonder where a species has gone whose rate of reproduction was so low that it required on an average at least 2 years for a pair to reproduce its own number under normal circumstances. The prairie hen and other species of grouse and quail have disappeared from much of their former range and are scarce elsewhere. The wild turkey, whose range was once so extensive, is extinct except in a few isolated localities, where it is rapidly decreasing. Ducks are greatly lessened in numbers almost everywhere. Shore birds are well on their way to ex-

(42) Hornaday, William T., The Destruction of Our Birds and Mammals. A Report on the Results of an Inquiry, Ann. Rept. N. Y. Zool. Soc. for 1898; republished, with addenda, in 1901. Our Vanishing Wild Life. 1913.

(43) Deane, Ruthven, The Passenger Pigeon—Only One Bird Left, The Auk, Vol. XXVIII, p. 262, 1911.

(44) Hodge, C. F., The Passenger Pigeon Investigation, The Auk, Vol. XXVIII, pp. 49-53, 1911; A Last Word on the Passenger Pigeon, The Auk, Vol. XXIX, pp. 169-175, 1912.

(45) Palmer, T. S., A Review of Economic Ornithology in the United States, U. S. Dept. Agric., Yearbook for 1899, p. 269.

termination (46). At a farmers' contest in Georgia in 1911, 11,231 meadowlarks were killed for prizes (47).

While the slaughter of game birds by sportsman and market hunters has been in progress, the destruction of non-game birds for millinery purposes has been even greater. The terrific drain of the feather trade upon bird life is not generally appreciated. Since dealers discovered that the world was awakening to the enormity of the destruction and its disastrous results, general statistics upon the subject, and especially relating to the use of our native, law-protected species, are unobtainable. Isolated items become known from time to time, and a few of these culled from various sources may throw some light upon the subject. Many of the birds used are of species which range over the United States in summer, but retire to Central or South America for the winter, so that their destruction even in Guatemala or Venezuela directly affects us. It is quite likely that the slaughter will continue in out-of-the-way places so long as the market furnishes a demand for bird plumage. The work of the Audubon Societies and other organizations and individuals in discouraging the use of plumage, except that of the domestic birds, is producing good results. The non-game birds are now protected by law in most of our states and some foreign countries, but a decisive blow would be the adoption of the plan now under consideration in Germany and elsewhere prohibiting the importation of foreign plumage, carrying with it even provisions prohibiting the wearing of the plumage of wild birds.

According to Forbush (48), in Oregon, from 1900 to 1908, 20 to 30 camps were engaged in killing grebes for the feather trade; over 1,500,000 egrets were killed in Venezuela in 1898 for their plumes; 400,000 hummingbirds were shipped from the West Indies to 1 London dealer in 1 year; the birds of paradise are being exterminated for their plumage, 2 dealers for some years prior to 1907 shipping 12,000 of the skins every 3 months; 250,000 albatrosses were killed in 1 year on Pacific Islands.

Palmer tells us (49) that 3,000 terns were marketed from Long Island by 1 gunner in 1883, and 40,000 killed at Cape Cod about the same time, while in Florida 1 man boasted that he and his companion killed 130,000 herons, egrets and terns in one winter. Most of these birds are killed during the nesting season when plumes are at their best, thus preventing reproduction.

Sullivan (50) says that at one auction in London 400,000 bird skins from America and 350,000 from India were sold, and that 70,000 skins of songbirds were taken on Long Island in 4 months. A recent London sale involved 19,029 birds of paradise (51).

(46) Judd, Sylvester D., The Grouse and Wild Turkeys of the United States, and their Economic Value, U. S. Dept. Agric., Biol. Surv., Bull. 24; The Bobwhite and other Quails of the United States in their Economic Relations, ibid., Bull. 21. McAtee, W. L., Our Vanishing Shorebirds, ibid., Circular No. 79. Fisher, A. K., Two Vanishing Game Birds: The Woodcock and the Wood Duck, U. S. Dept. Agric., Yearbook for 1901, pp. 447-458. Bailey, Vernon, Birds Known to Eat the Boll Weevil, U. S. Biol. Surv., Bull. No. 22, p. 15. Hornaday, W. T., Our Vanishing Wild Life. 1913.

(47) Bird-Lore, Vol. XIII, p. 123, 1911.

(48) Forbush, E. H., Fourth Annual Report of State Ornithologist (Mass.), for 1911, 24th Ann. Rept. Mass. St. Brd. Agric., 26-27. See also Bird Lore, Vol. II, p. 34, 1900; Vol. VII, pp. 339-340, 1905.

(49) Palmer, T. S., Review of Economic Ornithology, ibid, pp. 273-274.

(50) Sullivan, R. H., The Economic Value of Bird Life, Exten. Dept. Kansas State Agric. Coll., Agricultural Education, Vol. III, No. 7, p. 13.

(51) Museum News, Vol. VII, p. 54, 1912.

The 10 tons of ptarmigan wings contained in one shipment from Russia, mentioned in Englehardt's "Russian Province of the North," has been so often referred to in popular ornithological literature that it is almost a shame to mention it again.

Less than 4 years ago 15 Japanese subjects were arrested by the United State Revenue Cutter Thetis for poaching on Laysan, in the Hawaiian Islands. They had in their possession about 119,000 bird wings, and had previously shipped 128,000. Eight more arrested on Lisiansky had about 140,000 wings and had shipped about 108,000 (52).

If all the cats could be locked up during the time when young birds are leaving the nests, it would immediately result in a large increase in the number of insectivorous birds. Forbush estimated that cats destroy 1,500,000 birds in New England annually, while Fisher estimated it at 3,500,000 for New York alone. Certain it is that in the towns and cities they succeed in capturing a very large proportion of the young birds. The case of the small boy with a cheap rifle and a natural propensity for killing and for collecting eggs, needs some attention. That is largely a matter of education, and can best be taken care of by teaching the boys the value of birds and the necessity of their protection.

The early bird laws in the United States provided for the destruction of certain birds by the payment of bounties. Now the great majority of the states have passed the A. O. U. law (drafted by the American Ornithlogists' Union) or one similar to it, which provides for the protection of all non-game birds except a few designated species which may be considered harmful (53). The Colorado law (54), for example, protects all except the English sparrow, sharp-shinned hawk, Cooper's hawk, goshawk, duck hawk, great horned owl, pinyon jay, magpie, bluejay and eagles. Just what is meant by bluejay has not been determined. The bird known to ornithologists by that name is very rare in Colorado and confined to the eastern part of the state. Possibly the law-makers intended to designate by that name the long-crested jay, which is a very different bird.

The McLean law, just passed by Congress, places all migratory birds under the jurisdiction of the United States, and gives the Department of Agriculture power to regulate the hunting of them.

SYSTEMATIC DISCUSSION

PYGOPODES—Grebes, Loons, Auks, Etc. (Diving Birds).

These birds are for the most part not of economic importance except in isolated localities, and their habits have not been closely studied. Only the grebes and loons visit our region.

Auklets and young murres are said to live largely upon crustaceans, but

(52) Army and Navy Register, Feb. 19, 1910, quoted at length in The Auk, Vol. XXVII, pp. 243-244, 1910.

(53) Palmer, T. S., Extermination of Noxious Animals by Bounties, U. S. Dept. Agric., Yearbook for 1899, pp. 55-68; Legislation for the Protection of Birds Other than Game Birds, U. S. Biol. Surv., Bull. 12, 1900 (Revised edition 1902). Lantz, D. E., Bounty Laws in Force in the United States, July 1, 1907, Yearbook for 1907, pp. 560-565. Oldys, Henry, et al., Game Laws for 1910, Farmers' Bull. No. 418, 1910 (this supersedes bulletins for preceding years).

(54) Laws of 1903, Colorado, pp. 227-229.

adult murres incline toward fish. A downy young loon was found with a 6-inch tom-cod in his gullet. Grebes are not so strongly addicted to a fish diet as is generally supposed, the vegetable portion of their diet making them good table birds (55). Two eared grebes examined by Aughey contained 14 grasshoppers, a few other insects, crayfish and part of a fish (56). Stomachs of 57 horned grebes contained feathers up to 66%, but ignoring the feathers, the balance consisted of beetles 23.3%, other insects nearly 12%, fishes 27.8%, crayfish 20.7%, other crustaceans 13.8%, and snails, spiders and vegetation in small amounts (57).

LONGIPENNES – Gulls, Terns, Etc.

Some of the gulls and terns are very useful, and probably all are practically harmless, on the whole. Most species of both feed largely upon fishes, but also take many insects and other pests, especially those which frequent the interior regions. Gulls are well known as scavengers about harbors, and for that reason have been long protected by local laws. As hereinbefore noted, gulls once saved Utah crops from crickets. Though people insist upon calling all gulls "sea gulls," Franklin's gull frequents inland lakes and marshes and often does much good. Ninety-three stomachs from various places showed an average of 43% grasshoppers in their food, many of the stomachs being filled with from 50 to 90 of these destructive insects. During mouse and lemming plagues gulls have been found feeding extensively upon those rodents. Probably the ring-billed gull, common in migration in Colorado, has similar habits. The black tern, our common one in Colorado, feeds chiefly upon insects—about 70% insects and 20% fish on an average (58). Aughey, in his great work upon the food of Nebraska birds, examined the stomachs of the pomarine jaeger and Franklin's, great black-backed, herring, and ring-billed gulls, and found all to contain grasshoppers or locusts and other insects, with usually fish, frogs, crayfish and mollusks, while the Forster's, arctic, least, and black terns were found to be very highly insectivorous (59).

TUBINARES – Albatrosses, Petrels, Etc.

The albatrosses, fulmars, shearwaters, and petrels are marine, and have no economic value to people living far in the interior of North America.

STEGANOPODES – Boobies, Cormorants, Pelicans, Etc.

Of this order, only the cormorants and pelicans visit the Southern Rocky Mountain Region, a few of each passing through Colorado in migration. Pelicans feed chiefly upon fishes, and cormorants take chiefly fishes and crustaceans. They are not common enough in this region to be of any importance. The anhinga, or water turkey, of the South, feeds chiefly upon

(55) Judd, U. S. Dept. Agric., Yearbook for 1900, p. 433; U. S. Biol. Surv., Bull. No. 17, p. 79.

(56) Aughey, First Rept. U. S. Entom. Com., App. II, p. 62.

(57) McAtee and Beal, U. S. Dept. Agric., Farmers' Bull. No. 497, pp. 18-19.

(58) McAtee and Beal, Farmers' Bull. No. 497, pp. 21-26. Lantz, U. S. Biol. Surv., Bull. No. 31, p. 53. For Franklin's Gull see also Farmers' Bull. No. 513, p. 31.

(59) Aughey, First Rept. U. S. Entom. Com., App. II, pp 60-62.

fishes (60). Five pelicans from Nebraska all contained insects, from 21 to 67 each, with crayfish, fish and frogs (61).

ANSERES—Ducks, Geese and Swans

Wild ducks, geese and swans are almost altogether harmless, and provide recreation for an army of sportsmen. As a source of food they cannot under present conditions be deemed of great importance, as the cost of obtaining them far exceeds their value as food. Most of the species feed to a great extent upon aquatic plants, though probably all take some aquatic invertebrates, such as snails, crustaceans, etc., and some species, such as the mergansers, feed largely on small fishes (62). During grasshopper outbreaks domestic ducks have been found with from 200 to 250 grasshoppers in their stomachs; young mallards have been seen "stuffing themselves with Mayflies;" young wood ducks caught feeding on Mayflies and locusts; one duck in Louisiana in February contained 72,000 seeds; and the stomach of a young mallard was filled with grasshoppers (63). Aughey examined the stomachs of 8 snow geese, 9 Canada geese, 10 mallards, 7 pintails, 9 green-winged teal, 1 blue-winged teal, 1 shoveller, 9 wood ducks, 4 buffleheads and 1 ruddy duck, all of which contained insects, usually in large numbers, chiefly locusts, the remainder of the food consisting of mollusks and a little vegetation (64). Ducks have rapidly decreased in numbers during the last half century, and the wood duck, which possesses the finest plumage of all American ducks, is almost extinct (65).

ODONTOGLOSSAE—Flamingoes

Flamingoes do not visit our region, and have little economic importance, but should be preserved from the plume hunters in southern waters, on account of their unique beauty.

HERODIONES—Herons, Storks, Bitterns, Ibises, Etc.

The herons have been much persecuted because of the widespread belief that they live almost entirely upon fish, especially the great blue heron, which in Colorado is usually miscalled the sandhill crane. The fishes taken by herons are not as a rule very useful to the human race. If harm is done by these birds, it is in the destruction of snakes, rather than fish, and in this respect they do much good in the South by destroying the young moccasins. Chas. W. Smiley (in Bien. Rept. Fish Com. Colo., 1884) reports that a night heron shot at the Washington carp ponds contained heads of 78 young carp, which would naturally be the case where young fishes are so easily obtained as in the ponds of a hatchery.

Judd found only fish in the stomachs of 10 adult and 10 young black-crowned night herons, but found 20 dragonflies in 1 green heron, and praises the white egret as a destroyer of crayfish in Louisiana, where this

(60) Baynard, The Wilson Bulletin, Vol. XXIV, p. 169.
(61) Aughey, 1st Rept. U. S. Entom. Com. App., II, p. 60.
(62) Judd, U. S. Biol. Surv., Bull. 17, pp. 53, 80-81. McAtee, W. L., Three Important Wild Duck Foods, U. S. Biol. Surv., Circular No. 81.
(63) Judd, U S. Dept. Agric., Yearbook for 1900, p. 435. Fisher, North American Fauna, No. 7, p. 15. Farmers' Bull. No. 513, p. 5. Bryant, Univ. Cali., Pub. Zool., Vol. XI, No. 1, pp. 12-13
(64) Aughey, First Rept. U. S. Entom. Com., App. II, pp. 57-60.
(65) Fisher, U. S. Dept. Agric., Yearbook for 1901, pp. 447-458.

crustacean damages the levees (66). Lantz (67) recommends the protection of herons as "persistent enemies of meadow mice," the stork and ibis also doing good work along this line, and the great blue heron being especially valuable in California in destroying gophers. Bryant (68) found 1 stomach of the blue heron to contain 2 gophers, and 1 Anthony's green heron contained 15% grasshoppers. Aughey (69) found 16 grasshoppers in a bittern, and 11 in a great blue heron. Baynard (70) has just published some surprising figures, which I give below in tabular form, the food of the adults being based upon examination of the stomachs, and that of the nestlings upon food disgorged at nest just after they were fed by the parents. The snakes taken were mostly young moccasins and the fishes were mostly young catfish and suckers:

	Snakes	Lizards	Frogs	Fishes	Crayfish	Dragonflies	Cutworms	Grasshoppers
Louisiana Heron, 1 adult	.....	.....	.....	.....	.....	.....	.....	200
Louisiana Nestlings, 50 meals	.....	6	8	.....	67	.....	17	2,876
Little Blue Heron, 1 adult	1	.....	2	.....	3	.....	3	51
Little Blue Heron Nestlings, 50 meals	.....	8	37	.....	142	.....	147	1,900
Green Heron, 1 adult	.....	.....	3	.....	6	.....	2	16
Night Heron, nestlings, 50 meals	.....	.....	.....	641	60	79	.....	.....
Snow Egret, nestlings, 50 meals	7	2	.....	120	29	.....	91	762
Egret, nestlings, 50 meals	47	.....	297	61	176	.....	.....	.....
Glossy Ibis, 1 adult	1	.....	.....	.....	19	.....	14	12
White Ibis, nestlings, 50 meals	42	.....	.....	.....	602	.....	352	308

PALUDICOLAE—Cranes, Rails, Coots, Etc.

Cranes are great enemies of field mice, and take more different species of mice than herons do, as they inhabit both uplands and lowlands (71). A young crane in captivity ate a quart of cicadas daily (72). Doubtless they destroy innumerable grasshoppers. Four Nebraska stomachs contained 263 locusts, 202 other insects and some seeds (73). Cranes pass through Colorado and Nebraska, but seldom nest here. The nesting bird generally called crane is the great blue heron.

Rails and coots feed to a considerable extent upon aquatic vegetation, but are also quite insectivorous. Contrary to general opinion, they are very good table birds. One sora rail contained 200 wild rice seeds (74); a black rail contained 11 grasshoppers, 27 other insects and some seeds and other vegetation; 7 king rails contained 234 locusts, 212 other insects and some other seeds; 9 coots all contained insects—214 locusts, 269 other insects—and all contained fresh-water mollusks; while a Florida gallinule from Nebraska contained 7 grasshoppers, 29 other insects, with seeds and other vege-

(66) Judd, U S. Dept. Agric., Yearbook for 1900, p. 435; U. S. Biol. Surv., Bull. No. 17, p. 81.
(67) Lantz, U. S. Dept. Agric., Yearbook for 1909, p. 217; U. S. Biol. Surv., Bull. No. 31, pp. 52-53.
(68) Bryant, Univ. Cali. Pub. in Zool., Vol. XI, No. 1, p. 9.
(69) Aughey, First Rept. U. S. Entom. Com., App. II, p. 55.
(70) Baynard, Wilson Bulletin, Vol XXIV, pp. 167-169, 1912.
(71) Lantz, U. S. Biol. Surv., Bull. No. 31, p. 53.
(72) Judd, U. S. Dept. Agric., Yearbook for 1900, p. 433.
(73) Aughey, First Rept. U. S. Entom. Com., App. II, p. 56.
(74) Judd, U. S. Biol. Surv., Bull. No. 17, p. 81.

tation (75). Chas. W. Smiley (in W. E. Sisty, Bien. Rept. Fish Com. Colo., 1884) is quoted as saying that a "marsh hen" shot at the Washington carp ponds contained 38 young carp, which would naturally be the case about a hatchery.

LIMICOLAE—Shore Birds

(Avocets, Stilts, Phalaropes, Woodcocks, Snipes, Sandpipers, Curlews, Plovers, Turnstones, Etc.)

This order contains some of the finest game birds—the woodcocks, snipes and plovers. Some of the species are also of great value as destroyers of insects, a fact not generally recognized. Unfortunately many of them are diminishing rapidly in numbers (76).

McAtee says that 9 species are known to take mosquitoes, 4 take horse-flies, 8 take crane flies, 6 take weevils and 24 take grasshoppers (77). Stomachs of 149 birds of 23 species nearly all contained locusts, all contained insects of some kind, and few contained anything else (78).

Howell (79) reports that 48 stomachs of the upland plover were filled with weevils. According to McAtee and Beal (80), in 163 stomachs of the same species 97% of the contents was animal matter, chiefly injurious or neutral insects. The killdeer, so abundant throughout Colorado, is decidedly insectivorous. One stomach in California contained only grasshoppers (81), while 9 in Nebraska all contained insects, 268 locusts, 190 other insects, and in one a few seeds (82). Three nestling sandpipers (solitary and Pirbilof) contained only insects, with the exception of 1 seed and 1 spider, and 4 nestling woodcocks contained only caterpillars (83).

GALLINAE—Grouse, Quail, Turkeys, Etc.

As in case of the shore birds, various species of this order have been ruthlessly slaughtered. Sportsmen are now demanding their protection, and investigation of their food habits shows that the farmer has even greater reason for preserving some of the species, especially the quail, though some of the grouse which inhabit the grain-growing regions have been known to damage unthreshed grain in the autumn when they were more abundant.

The table on next page is a condensation of information contained in Judd's reports (84), ignoring the fractions.

When we consider the size of these birds and large amount of food they require, the percentage of insects and weed seeds means an enormous number of these pests destroyed. One bobwhite contained 5,000 seeds of the foxtail grass, another contained 10,000 pigweed seeds, and a California quail contained 2,000 dog fennel seeds. As with other birds, the downy young

(75) Aughey, First Rept. U. S. Entom. Com., App. II, pp. 56-57.
(76) Fisher, Two Vanishing Game Birds: The Woodcock and the Wood Duck, U. S. Dept. Agric., Yearbook for 1901, pp. 447-458. McAtee, Our Vanishing Shorebirds, U. S. Biol. Surv., Circular No. 79. Hornaday, Our Vanishing Wild Life. 1913.
(77) McAtee, U. S. Biol. Surv., Circular No. 79, pp. 2, 4, 6.
(78) Aughey, First Rept. U. S. Entom. Com., App. II, pp. 49-55.
(79) Howell, U. S. Biol. Surv., Bull. No. 29, p. 20.
(80) McAtee and Beal, U. S. Dept. Agric., Farmers' Bull. No. 497, pp. 15-16.
(81) Bryant, Univ. Cali. Pub. in Zool., Vol. XI, No. 1, p. 9.
(82) Aughey, First Rept. U. S. Entom. Comm., App. II, p. 49.
(83) Judd, Food of Nestling Birds, U. S. Dept. Agric., Yearbook for 1900, pp. 432-433.
(84) Judd. U. S. Biol. Surv., Bull. No. 21 (Quails), and Bull. No. 24 (Grouse and Turkeys). See also Judd, U. S. Dept. Agric., Yearbook for 1903, pp. 193-204.

grouse and quail are much more insectivorous than the adults. The browse in the food of the dusky grouse and spruce grouse is mostly coniferous foliage. The sage grouse feeds principally upon leaves, shoots and buds, especially the wild sages. It is the largest North American member of the family except the turkey, and is a good table bird if drawn immediately after killing and properly prepared. In Colorado it is common in the sage brush areas of the northern and northwestern parts of the state, the dusky grouse is common throughout the mountains, 1 form of the sharp-tailed grouse

	Number of stomachs examined.	Average percent of leaves, buds, etc.	Average percent wild berries, etc.	Average percent seeds, mostly weed	Average percent insects	Average percent grain	Percent nuts, etc.
Sharp-tailed Grouse	43	31	27	7	10	20	.....
Dusky Grouse	45	68	20	4	6	.....	.....
Ruffed Grouse	208	48	28	11	10	.....	.....
Prairie Hen	71	25	11	14	14	31	.....
Spruce Grouse	8	61	19	18	.....	.....	.....
Wild Turkey	16	24	32	20	15	.....	4
Bobwhite	918	.....	9	52	15	17	.....
California Quail	601	22	.....	58	2	6	.....
Gambel's Quail	28	63	.....	31	.....	3	.....
Mountain Quail	23	24	.....	46	.....	18	.....
Scaled Quail	47	4	.....	52	29	.....	.....

occurs in a few places, and the prairie hen is occasionally seen on the plains. The ptarmigan, still common at and above timber line in Colorado, feeds chiefly, so far as known, upon buds, berries, leaves, etc. The ring-necked pheasant has been introduced in the Denver Basin. McAtee and Beal (85) report that oats and wheat formed 34% of the contents of 12 stomachs of this species from Oregon and Washington, doubtless waste, as they were autumn and winter birds, the next largest item of food being March flies, of which one contained 360 and another 432, and 8,000 chickweed seeds were in one. The bobwhite has been introduced into much of the plains area of Colorado, and the California quail in a few places.

The following figures adapted from Aughey's report show actual numbers of insects, not merely averages, in stomachs of various species (86):

	No. of stomachs examined	Average No. of locusts contained	Average No. of other insects	Other food.
Wild Turkey	6	45	18	Seeds and grain.
Sage Grouse	4	47	3	Sage leaves.
Sharp-tailed Grouse	10	43	22	Seeds.
Prairie Hen	21	41	10	Seeds and buds.
Bobwhite	21	25	14	Seeds.

Judd estimates that in Virginia and North Carolina, from September 1 to April 30, the bobwhite eats 1,341 tons of weed seeds, and in the remaining 6 months, when one-third of its food is insects, it takes 340 tons of weed seeds (87).

(85) McAtee and Beal, U. S. Dept. Agric., Farmers' Bull. No. 497, p. 14.
(86) Aughey, First Rept. U. S. Entom. Com., App. II, pp 46-48.
(87) Judd, U. S. Biol. Surv., Bull. No. 21, pp. 14-15.

COLUMBAE—Pigeons and Doves

Since the extermination of the passenger pigeon, the mourning ("turtle") dove is the most important member of this order, being abundant and widespread. It is "preeminently a seed-eater." One stomach contained 7,500 wood sorrel seeds, another contained 6,400 foxtail seeds, another contained 9,200 miscellaneous seeds. Seeds constitute 64% of its diet (88). Likely the band-tailed pigeon, which occurs sparingly in Colorado, and the other doves and pigeons of the United States, have similar habits. In the destruction of weed seeds these birds are very valuable, and they seldom molest crops of any kind.

RAPTORES—Eagles, Hawks, Owls and Vultures

Hawks and owls have been persecuted more than any other group of birds, under the false impression that they are all enemies of the poultry raiser. Nearly all men seem to consider the killing of hawks a patriotic service, as well as a mark of skill. Since the masterly study of the habits of birds of this order by Fisher and others((89) there is no longer any excuse for ignorance of the usefulness of most species.

Vultures, including the California condor, turkey vulture ("buzzard") and black vulture, feed chiefly upon carrion, are very useful and should be rigorously protected as scavengers. Their numbers in the West have been greatly reduced by setting out poison for coyotes.

Eagles are not plentiful enough to be of great economic importance, either way. Fisher considers the useful and harmful habits of the bald and golden eagles about balanced. They destroy many harmful rodents, but also destroy some young stock, game birds and fawns. The numerous stories of their carrying off young children are nearly all without foundation. Fish is the favorite food of the bald eagle, and contrary to general opinion it will eat carrion.

Nearly all of our hawks and owls are useful, some of them being considered among the most useful birds. Only 6 out of over 70 species and subspecies in the United States are considered harmful: Gyrfalcon, duck hawk, sharp-shinned hawk, Cooper's hawk, goshawk and great horned owl. In most states all except these are now protected by law, but it has not been a great while since bounties were offered in many states for the destruction of all the species. Cooper's hawk, a small species strongly marked with dark stripes below, is "preeminently a chicken hawk," a name which has been generally applied to the red-tailed hawk, red-shouldered hawk and other large hawks which seldom touch poultry. The sharp-shinned hawk, still smaller and marked by bars below, is as bad, except that it is too small to take any but young chickens, so it takes an undue proportion of wild birds.

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(88) Judd, U. S. Dept. Agric., Yearbook for 1898, pp. 231-232. Dutcher, Nat. Aud. Soc., Educational Leaflet No. 2. Sullivan, Kas. St. Agric. Coll., Agricultural Education, Vol. III, No. 7, p. 32.

(89) Fisher, A. K., The Hawks and Owls of the United States in their Relation to Agriculture, U. S. Dept. Agric., Div. Orn. & Mam., Bull. No. 3, 1893, 201 pages; Hawks and Owls from the Standpoint of the Farmer, U. S. Dept. Agric., Yearbook for 1894, pp. 215-232 (revision in U. S. Biol. Surv. Circular No. 61, 1907). Oberholser, Harry C., The North American Eagles and their Economic Relations, U. S. Biol. Surv., Bull. No. 27, 1900. Keyes, Charles R., A History of Certain Great Horned Owls, The Condor, Vol. XIII, pp. 5-19, 1911; reprinted in Ann. Rept. Smithsonian Inst. for 1911, pp. 395-405, 1912.

Swainson's hawk is known to live largely upon grasshoppers in the summer and early autumn.

The following table has been compiled from Fisher's great bulletin on hawks and owls, to show at a glance what proportion of these birds of various species take the various kinds of food, throwing the varieties of each species together:

	No. of stomachs examined	Poultry and Game Birds	Other Birds	Mice	Other mammals	Reptiles	Amphibians	Fish	Insects	Mollusks and Crusteceans	Carrion and Offal	Empty
Swallow-tailed Kite	6	...	...	...	...	2	1	...	6	...	...	...
White-tailed Kite	1	...	...	1	...	...	...	...	...	...	...	...
Mississippi Kite	4	...	...	...	...	...	...	...	4	...	...	...
Marsh Hawk	124	7	34	57	22	7	2	...	14	...	...	8
Sharp-shinned Hawk	159	6	93	6	...	...	...	...	5	...	...	52
Cooper's Hawk	133	34	52	...	11	3	1	...	2	...	...	39
Goshawk	28	9	2	...	10	...	...	...	3	...	...	8
Harris' Hawk	6	...	...	...	5	...	...	...	1	...	...	1
Red-tailed Hawk	562	54	51	278	131	37	...	3	47	8	13	89
Red-shouldered Hawk	220	3	12	104	40	20	39	...	92	7	2	14
Zone-tailed Hawk	5	...	...	...	...	2	3	1	...	...	...	1
Swainson's Hawk	18	...	...	...	7	3	3	...	8	...	...	3
Broad-winged Hawk	65	...	2	15	13	11	13	...	30	4	...	7
Mexican Black Hawk	6	...	...	...	...	1	3	2	...	...	...	...
Roughleg Hawk	49	...	...	40	5	1	...	...	1	...	...	4
Ferruginous Roughleg	1	...	...	...	1	...	...	...	...	...	...	...
Golden Eagle	6	...	1	...	2	...	...	...	...	...	2	1
Bald Eagle	21	1	...	...	5	...	...	9	...	...	2	5
Prairie Falcon	11	3	5	...	2	...	...	...	2	...	...	3
Duck Hawk	20	7	9	1	...	...	...	...	2	...	...	4
Pigeon Hawk	56	3	41	2	...	...	...	...	16	...	...	5
Richardson's Merlin	4	...	2	...	...	...	...	...	1	...	...	1
Sparrow Hawk	320	1	53	89	12	12	...	...	215	...	...	29
Audubon's Caracara	2	...	...	...	1	...	...	...	...	...	1	...
Osprey	12	...	...	...	...	...	...	11	...	...	...	1
Barn Owl	39	1	3	17	17	...	...	...	4	...	...	7
Long-eared Owl	107	1	15	84	5	...	...	...	1	...	...	15
Short-eared Owl	101	...	11	77	7	...	...	...	7	...	...	14
Barred Owl	109	5	13	46	18	...	4	2	14	9	...	20
Great Gray Owl	9	...	1	7	4	...	...	...	...	...	...	...
Saw-whet Owl	22	...	1	17	...	...	...	...	1	...	...	3
Screech Owl	255	1	38	91	11	...	4	1	100	9	...	43
Flammulated Owl	2	...	...	...	...	...	...	...	2	...	...	...
Great-horned Owl	127	31	8	13	65	...	...	1	10	...	...	17
Snowy Owl	38	2	9	18	2	...	...	...	...	...	...	12
Hawk Owl	1	...	...	1	...	...	...	...	...	...	...	...
Burrowing Owl	32	...	...	...	3	...	...	...	30	...	...	1
Pygmy Owl	6	...	1	1	...	...	...	...	1	...	...	2
Elf Owl	3	...	...	...	1	...	...	...	3	...	...	...

Aughey (90) gives statistics from which the numbers of locusts and other insects found in stomachs examined are computed by him as follows:

(90) Aughey, First Rept. U. S. Entom. Com., App. II, pp. 42-45.

	Number of stomachs	Average number of locusts	Average number of other insects	Other food.
Swallow-tailed Kite	3	43	27	
Marsh Hawk	6	41	26	Reptiles and gopher.
Prairie Falcon	1	16	.....	
Richardson's Merlin	2	12	.....	
Sparrow Hawk	10	5	31	Mammals, birds, frog.
Red-tailed Hawk	1	.....	37	Quail.
Swainson's Hawk	4	32	31	Gophers, rabbit, mouse.
Rough-leg	1	.....	70	Lizard, gopher.
Barn Owl	3	13	39	Mice.
Great-horned Owl	1	.....	30	Gopher.
Screech Owl	8	27	27	Mice, bird
Short-eared Owl	2	15	8	Gopher, rabbit.
Burrowing Owl	9	35	23	Mouse, lizard, prairiedog.

PSITTACI—Paroquets, Parrots, Etc.

The Carolina paroquet, whose range once extended from Maryland to Colorado and southward, is extinct except in a few southern localities, and hence is now of little economic importance one way or the other.

COCCYGES—Cuckoos, Trogons and Kingfishers

The trogon is of no importance to us, being confined to the extreme southern portion of the United States—Texas and Arizona.

The road-runner lives on reptiles, batrachians, small mammals and insects (91).

The American cuckoos, unlike the European species, are not parasitic in their nesting habits, and are considered among our most useful birds, because they destroy great numbers of hairy caterpillars, which most other birds cannot eat. Caterpillars form 48% of their food, 155 stomachs having contained 2,770 caterpillars, an average of 21 each. One contained 251 tent caterpillars, another contained 217 fall webworms. Tent caterpillars, at the time when they are defoliating the trees, form 50% of the food of the cuckoos (92). One contained 325 fall webworm larvæ (93). Another contained more insects than 522 English sparrows, yet the sparrows have been permitted to drive out the cuckoos (94). Canker worms constituted 75%, other caterpillars 20% and vine leaf chafers 5% of the contents of a stomach from a canker-infested orchard (95). Eleven stomachs in Nebraska averaged 35 locusts and 13 other insects (96). The nestlings are fed on grasshoppers and smooth caterpillars (97).

But little can be said in favor of kingfishers from an economic point

(91) Lantz, U. S. Biol. Surv., Bull. No. 31, p. 51. Anthony, The Auk, Vol. XIV, p. 217.

(92) Beal, How Birds Affect the Orchard, U. S. Dept. Agric., Yearbook for 1900, p. 297; The Food of Cuckoos. U. S. Biol. Surv., Bull. No. 9, pp. 7-14; Farmers' Bull. No. 54, pp. 5-6.

(93) Judd, U. S. Biol. Surv., Bull. No. 17, pp. 28-29.

(94) Barrows and Riley, U. S. Dept. Agric., Div. Orn. & Mam., Bull. No. 1, pp. 80, 108, 123.

(95) Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. 1, No. 6, p. 16.

(96) Aughey, First Rept. U. S. Entom. Com. App., II, pp. 39-40.

(97) Judd, U. S. Dept. Agric., Yearbook for 1900, p. 428.

of view. They live chiefly upon fish, mostly small species of little value, and also take some mice and frogs. Even half-grown young are fed on fish(98). It has been estimated that 1 pair takes 6,000 fish in a season, but sometimes they take "vast numbers of grasshoppers, crickets, frogs and lizards" (99).

PICI—Woodpeckers, Etc.

Excepting the sapsuckers, all woodpeckers are considered, under ordinary conditions, beneficial, and some of them highly useful (100). On an average 63% of the food of woodpeckers consists of insects (101), largely ants, caterpillars and beetles, especially the wood-boring larvæ of beetles and moths which are destructive to trees. Their prey includes the codling moth larvæ, a great enemy of orchards (102). At least half of the spruce-bark beetles of the northeastern states are eaten by woodpeckers (103). One flicker stomach contained 5,000 ants and 2 others contained 3,000 each (104). The following table, combined from 2 tables in Beal's report, shows the percentages (omitting fractions) of animal matter, vegetable matter, ants and beetles in the food of various species (105) :

	No. of stomachs examined	Percent animal matter	Percent vegetable matter	Percent ants	Percent beetles
Three-toed Woodpecker	23	94	5	8	71
Arctic Three-toed Woodpecker	28	88	11	6	67
Williamson Sapsucker	17	86	13	85	.....
Red-cockaded Woodpecker	76	81	18	56	11
Nuttall's Woodpecker	53	79	20	8	28
Hairy Woodpecker	382	77	22	17	41
Downy Woodpecker	723	76	23	21	21
Pileated Woodpecker	80	72	27	39	22
Red-breasted Sapsucker	34	68	31	42	4
Red-shafted Flicker	183	67	32	53	6
Yellow-shafted Flicker	684	60	39	49	5
Yellow-bellied Sapsucker	313	49	50	34	6
Lewis' Woodpecker	59	37	62	11	9
Red-headed Woodpecker	443	33	66	5	18
Red-bellied Woodpecker	271	30	69	6	10
California Woodpecker	84	22	77	8	2
Total	3,453				
Average percentage		64	35	28	20

(98) Judd, U. S. Dept. Agric., Yearbook for 1900, p. 428.
(99) Sullivan, Kas. St. Agric. Coll., Agric. Educ., Vol. III, No. 7, p. 34.

(100) Beal, Preliminary Report on the Food of Woodpeckers, U. S. Dept. Agric., Div. Orn. and Mam., Bull. No. 7, 1895; Food of the Woodpeckers of the United States, U. S. Biol. Surv., Bull. No. 37, 1911. McAtee, Woodpeckers in Relation to Trees and Wood Products, U. S. Biol. Surv., Bull. No. 39, 1911. Lucas, The Tongues of Woodpeckers, Div. Orn. & Mam., Bull. No. 7, pp. 35-39; The Tongues of Birds, Ann. Rept. U. S. Nat. Mus. for 1895; pp. 1001-1020.

(101) Beal, U. S. Dept. Agric., Yearbook for 1908, p. 343.

(102) McAtee, U. S. Dept. Agric, Yearbook for 1911, p. 239

(103) Hopkins, U. S. Bur. Entom., Bull. No. 28 new ser., pp. 23, 25, 26.

(104) Beal, U. S. Dept. Agric,, Yearbook for 1900, p. 294.

(105) Beal, U. S. Biol. Surv., Bull. No. 37, p. 10.

The following table, combined from Aughey's report (106), shows the average number (not percentage) of locusts, other insects, and other food in stomachs examined by him:

	No. of stomachs examined	Average No. of locusts	Average No. of other insects	Other food
Hairy Woodpecker	6	26	32	
Downy Woodpecker	4	41	20	
Yellow-bellied Sapsucker	5	26	17	Seeds.
Red-bellied Woodpecker	2	.....	.....	½ locusts, ½ other insects
Red-headed Woodpecker	6	25	35	Grain.
Yellow-shafted Flicker	8	29	23	Grain.
Red-shafted Flicker	1	18	31	

The sapsuckers, when they occur in any number, are apt to do considerable damage. The United States Biological Survey recommended poisoning them, to which objections were made on the ground that the result would be to poison hummingbirds and other birds which resort to the holes made by the sapsuckers for sap. These objections have been answered in a recent article by McAtee (107).

MACROCHIRES—Nighthawks, Whip-poor-wills, Swifts and Hummingbirds

Nighthawks have very large stomachs, proportionately, which are kept filled to supply the motive power for their great activity. They feed almost exclusively upon flying insects, 20,000 flying ants having been found in 87 stomachs, averaging 230 each, and ranging in 24 of the stomachs, from 200 to 1,800. They are known to take 600 species of insects. One contained 60 grasshoppers, another 22, another 19 (108). Harvey found 500 mosquitoes in one stomach (109). Aughey (110) found 51 locusts and 10 other insects in 6 stomachs. Although not hawks at all, it is said that under the hawk bounty act in Pennsylvania thousands of dollars were paid in bounties on nighthawks (111).

The whip-poor-wills and poor-wills are almost entirely insectivorous. During a locust invasion 2 whip-poor-will stomachs were both found to be "crowded with locusts," and four-fifths of the contents of a poor-will stomach was grasshoppers and locusts (112).

The swifts are wholly insectivorous, taking in swift flight their prey, which consists chiefly of small insects such as mosquitoes, gnats and flies, though during locust invasions Aughey invariably found "more or less" locusts in their stomachs (113).

(106) Aughey, First Rept. U. S. Entom. Com., App. II, pp. 40-42.
(107) McAtee, The Auk, Vol. XXX, pp. 154-157, 1913.
(108) Beal, Remarks on the Economic Value of Nighthawks, Nat. Aud. Soc., Educational Leaflet No. 1; Farmers' Bull. No. 513, p. 23.
(109) Sullivan, Kas. St. Agric. Coll., Agric. Educ., Vol. III, No 7, p. 23.
(110) Aughey, First Rept. U. S. Entom. Com., App. II, p. 39.
(111) Pennock, Dela. St. Board Agric., Bull. No. 5, p. 13.
(112) Aughey, Ibid., p. 38.
(113) Aughey, Ibid., p. 39.

The tiny hummingbirds, "glittering fragments of rainbows," as Audubon called them, are of great aesthetic and scientific interest, and entitled to preservation. Economically they have few bad habits, though they do destroy some parasitic Hymenoptera, offsetting the damage they thus do by their good work in pollenizing flowers and destroying harmful insects. Their chief food is the nectar of flowers, which does not show in analyses of stomach contents. One stomach examined by Aughey (114) contained 4 small locusts. Warren (according to Sullivan) found spiders, beetles and other insects in 62 stomachs (115). Stomachs of 59 ruby-throated hummingbirds contained (ignoring the nectar item) Hymenoptera 36% (largely parasitic and hence useful), bugs 8.8%, gnats 2.5%, spiders 43.4%, vegetation 5.6%, while stomachs of 111 Anna's hummingbirds contained gnats and small flies 45%, bugs 17%, spiders 2%, Hymenoptera 35% (116).

PASSERES—Perching Birds (Song Birds)

The order Passeres includes over two-fifths of all the bird species found in the United States and Canada. Their food habits are varied, and our space permits only a brief summary of each family.

Tyrannidæ. The flycatchers feed mostly upon flying insects taken on the wing, though true flies constitute only a minor item of their diet. Stomachs of 3,398 specimens, representing 17 species, contained an average of 94.99% animal matter (chiefly insects), and only 5.01% vegetation. The percentages of the various elements of their food are tabulated as follows, omitting the fractions of percent which occur in the original table (117):

	Total animal food	Total vegetable food	Beetles	Wasps, bees and ants	Bugs	Flies	Grasshoppers and crickets	Moths and caterpillars	Miscellaneous insects	Spiders and Myriapods	Fruits	Miscellaneous vegetable food
Scissor-tailed Flycatcher	96	3	13	12	10	3	46	4	...	4	2	1
Kingbird	88	11	25	32	3	3	11	3	7	1	10	...
Arkansas Kingbird	90	9	17	31	5	...	27	7	...	...	9	...
Cassin's Kingbird	78	21	14	21	3	2	14	18	2	...	19	2
Crested Flycatcher	93	6	16	13	14	3	15	21	4	4	5	...
Ash-throated Flycatcher	92	7	7	26	20	12	5	17	1	...	7	...
Phoebe	89	10	15	26	10	6	12	8	8	...	4	5
Say's Phoebe	99	...	15	30	4	16	15	12	3	1	...	...
Black Phoebe	99	...	13	30	10	28	2	8	5	...	...	...
Olive-sided Flycatcher	99	...	6	82	3	...	1	4	1	...	...	...
Wood Pewee	98	1	14	28	5	29	3	12	2	2	...	...
Western Wood Pewee	99	...	5	39	1	44	...	5	3	...	...	...
Yellow-bellied Flycatcher	97	2	16	46	4	14	...	5	...	8	2	...
Western Yellow-bellied Flycatcher	99	...	8	38	8	31	...	6	...	4	...	...
Acadian Flycatcher	97	2	13	39	6	8	6	18	...	2	2	...
Alder Flycatcher	96	3	17	41	7	14	3	7	2	...	3	...
Least Flycatcher	97	2	21	41	11	11	2	7	...	2	1	...
Average	94	5	14	34	7	13	9	9	2	2	4	...

(114) Aughey, Ibid., p. 39.
(115) Sullivan, Ibid., p. 32.
(116) Beal and McAtee, U. S. Dept. Agric., Farmers' Bull. No. 506, pp. 15-17.
(117) Beal, Food of Our More Important Flycatchers, U. S. Biol. Surv., Bull. No. 44, pp. 5-6, 1912.

The kingbird is often called the "bee martin," and reputed an enemy of the honey bee, but of 665 stomachs only 22 contained honey bees—51 drones, 8 workers and 2 doubtful, a total of 61, and the destruction of a few drones is not harmful. On the other hand, 19 of the stomachs contained robber flies, which are great enemies of the bees (118). Over 100 Arkansas flycatchers and phœbes shot about apiaries all contained drone honey bees, but only 1 worker was found (119).

Alaudidæ. The horned larks, or shore larks, are our only representatives of this family. Meadowlarks belong to a different family. The winter food of horned larks is almost entirely weed seeds and waste grain from the fields, while the nestlings are fed chiefly on insects. Of 1,154 stomachs, 1,070 contained weed seeds and 206 contained nothing else, grain (chiefly waste) forming 40.2% in California and 12.2% elsewhere; grass and sedge seeds 26.21%; weed seeds (except in California) 63%, but only 50% in 259 California stomachs; insects about 20%. One stomach contained 42 locusts and 33 seeds (120).

Corvidæ. The crows, ravens, and jays may be placed in the doubtful list in some localities, though the harm they do to nesting birds and crops is nearly everywhere to a great extent offset, or more than offset, by their usefulness in destroying insects, mice and other pests. Crows and ravens are "among the most formidable bird enemies of field mice," taking the mice at every opportunity, while jays and magpies also destroy some (121).

The crow's food for the year, as shown by 909 stomachs, consists of rabbits 5%, mice 1.1%, carrion 3%, wild birds and their eggs 6%, poultry and eggs 4%, snakes 2%, amphibians 1.2%, fish 4%, crustaceans 9%, mollusks 3%, insects 23.5% (insects 1% in February and 67% in May), corn 25%, doubtless largely waste (122).

Jays, nutcrackers, crows and ravens examined by Aughey contained locusts (123). Reports of the blue jay's nest-robbing proclivities are conflicting. In 292 stomachs insects formed 23% of the food for the year (66% in August), corn 17.9%, nuts and large seeds 42%, and only 3 contained eggs of wild birds, 11 containing shells of domestic eggs (124). California and Steller's jays have very much the same general food habits as the blue jay, but the former does some damage to fruit (125). The long-crested jay of the Rockies has not been so much investigated, but its food habits are probably at least as favorable as those of any jay. Nestling crows, and

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(118) Beal, U. S. Biol. Surv., Bull. No. 44, pp. 11-15. See also Farmers' Bull. No. 54, p. 12.

(119) Beal, U. S. Biol. Surv., Bull. 34, p. 33, citing Bryant, Zoe, Vol. IV, pp. 57-58.

(120) McAtee, The Horned Larks in Their Relation to Agriculture, U. S. Biol. Surv., Bull. No. 23, pp. 12-23, 30-32. Beal, U. S. Biol. Surv., Bull. No. 34, pp. 44-47. Beal and McAtee, Farmers' Bull. No 506, pp 23-25. Judd, U S. Biol. Surv., Bull. No. 17, p. 93. Barrows, The Food of Horned Larks or Shore Larks, U. S. Dept. Agric., Rept. for 1892, pp. 193-197. Aughey, First Rept. U. S. Entom. Com., App. II, pp. 18-19.

(121) Lantz, U. S. Biol. Surv., Bull. No. 31, p. 50. Judd, Ibid., Bull. No. 17, pp. 53-54.

(122) Barrows and Swartz, The Common Crow of the United States, U. S. Dept. Agric., Div. Orn. & Mam., Bull. No. 6, pp. 3, 31. Barrows, The Food of Crows, U. S. Dept. Agric., Rept. for 1888, pp. 498-535.

(123) Aughey, First Rept. U. S. Entom. Com., App. II, pp. 35-36.

(124) Beal, The Blue Jay and its Food, U. S. Dept. Agric., Yearbook for 1896, pp. 197-206. Judd, U. S. Biol. Surv., Bull. No. 17, pp. 93-94.

(125) Beal, U. S. Biol. Surv., Bull No. 34, pp. 47-56.

probably jays and magpies as well, are at first fed principally on insects (126).

Icteridæ. Blackbirds have been known to do much damage to crops locally, where overabundant, and bounties have been paid for their destruction, but in most localities they do much more good than harm. That they destroy millions of cutworms and other pests is well known (127).

Red-wing, 1,083 stomachs, weed seeds 54.6%, grain 13.9%, grasshoppers 4.7% (17% in August), caterpillars 5.9% (20% in May), beetles 10% (128). The food of western species and subspecies of red-wings differs from these figures somewhat, as shown in detail by Beal (129).

Yellow-headed blackbird, 138 stomachs, insects 33%, weed seeds 28%, grain 38% (130).

Bronzed grackle (crow blackbird), 2,346 stomachs, insects 27%, and rusty grackle, 132 stomachs, insects about 42% (131).

The nestlings of all these species are at first fed exclusively on insects and spiders (132).

Cowbirds, 544 stomachs, insects about 33% (133).

Meadowlarks feed largely on grasshoppers, crickets and other ground insects and are very useful. In 238 stomachs, insects averaged 71.7%, even 6 taken with snow on the ground averaging 47%; grain 14%, weed seeds 11%. One contained 37 grasshoppers and another 54, which, of course, represented only part of the daily food. It is estimated that in one square mile meadowlarks destroy 30,000 grasshoppers in a month (134). This bird is also numbered among the enemies of the cotton boll weevil (135). Ninety-one stomachs of the western meadowlark, taken in California, contained insects 70%, grain 27%, weed seeds 2% (136). Fifty-four stomachs from Red Bluff, California, averaged 31% of cutworms, 66 from El Toro averaged 73.23% of grasshoppers (137).

Baltimore oriole, 113 stomachs, insects 83.4%, vegetation 16.6%, including very little fruit (138). Three stomachs from a canker-infested orchard contained beetles 60% (chiefly vine leaf chafers), canker worms 40% (139).

Bullock's oriole, 162 stomachs, insects 79%, vegetation 21% (fruit 9%) (140).

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(126) Judd, The Food of Nestling Birds, U. S. Dept. Agric., Yearbook for 1900, pp. 424-426.
(127) Sullivan, Kas. St. Agric. Coll., Agric. Educ., Vol. III, p. 34.
(128) Beal, The Food of the Bobolink, Blackbirds and Grackles, U. S. Biol. Surv., Bull. No. 13, pp. 33-44. See also Farmers' Bull. No. 54, pp. 19-21.
(129) Beal, U. S. Biol. Surv., Bull. No. 34, pp. 36-59.
(130) Beal, U. S. Biol. Surv., Bull. No. 13, pp. 30-33.
(131) Beal, U. S. Biol. Surv., Bull. No. 13, pp. 13, 24-30, 45-49. This is, in part, a revision of Crow Blackbirds and their Food, Yearbook for 1894, pp. 233-248.
(132) Beal, Ibid., and Judd, Yearbook for 1900, pp. 422-423.
(133) Beal, Ibid., Bull. 13, pp. 24-30.
(134) Beal, The Meadowlark and Baltimore Oriole, Agric. Yearbook for 1895, pp. 419-430; Farmers' Bull. No. 54, pp. 21-23. Judd, Yearbook for 1898, p. 431. Dutcher, The Meadowlark, Nat. Aud. Soc., Educ. Leaflet No. 3.
(135) Bailey, U. S. Biol. Surv., Bull. No. 22, p. 16. Howell, U. S. Biol. Surv., Bull. No. 25, p. 11; No. 29, p. 18.
(136) Beal, U. S. Biol. Surv., Bull. No. 34, pp. 65-68.
(137) Bryant, The Numbers of Insects Destroyed by Western Meadowlarks (*Sturnella neglecta*), Science, n. s., Vol. XXXVI, pp. 873-875.
(138) Beal, Agric. Yearbook for 1896, pp. 426-429; Yearbook for 1900, p. 298. Farmers' Bull. No. 54, p. 23. Judd, U. S. Biol. Surv., Bull. No. 17, p. 96.
(139) Forbes, Ill. St. Lab. Nat. Hist., Bull., Vol. I, No. 6, p. 14.
(140) Beal, U. S. Biol. Surv., Bull. No. 34, pp. 68-71.

Two orchard orioles from a canker-infested orchard contained canker worms 77%, other caterpillars 20%, ants 3% (141), while 11 from elsewhere contained insects 91%, vegetation 9%, nearly all mulberry (142).

Bobolinks are said to do $2,000,000 damage annually to southern rice fields, but in their northern breeding grounds they are more than half insectivorous, taking 90% of injurous insects in June (143).

Fringillidæ. This family, including over 12% of the bird species of the United States, is essentially a family of seed-eaters, but they take many insects in summer and many of them feed their young at first almost entirely on insects. Stomachs of the goldfinch, dickcissel, grasshopper sparrow, chipping sparrow, field sparrow, rose-breasted grosbeak and indigo bunting from a canker-infested orchard contained an average of 91% of insects, 40% being canker worms (144). Two pine siskins contained 1,900 black olive scales and 300 plant lice, and in one green-backed goldfinch there were 300 plant lice (145).

Half of the food of the rose-breasted grosbeak, two-thirds of that of the black-headed and blue grosbeaks, one-fourth of that of the gray grosbeak and cardinal, consists of insects, the balance largely weed seeds, while the nestlings of all are fed at first entirely upon insects (146). Probably the pine grosbeak of our higher Colorado mountains lives largely on conifer seeds, but Aughey found many locust eggs in five stomachs (146-a). The western evening grosbeaks, which come to Boulder every winter, feed almost entirely upon box elder seeds while here, so far as I have observed.

California and Anthony's towhees, 399 stomachs, insects 14%, weed seeds 51%, grain 28%. Spotted towhees (Pipilo maculatus and subspecies), 139 stomachs, insects about 30%, weed seeds 34%, grain 4.7%, mast 15.6%, fruit 17.7% (147).

Insects form on an average 25% of the food of our native sparrows and finches, for the year, and weed seeds 50% for the year, the latter item rising to 80% in the cold half of the year, the value of the sparrows being "greater than that of any other group of birds whose economic status has thus far been investigated." It is estimated that by the destruction of weed seeds these birds save $89,260,000 annually to the farmers. Visits to the field will often show that nine-tenths of the weed seeds produced have been destroyed by these birds (148).

In June 93% of the food of the chipping sparrow is insects, and 38% for the year (149). Stomachs of 500 slate-colored juncoes contained weed seeds 61.8%, grain 8%, insects 24% (150). Beal (151) estimated that the

(141) Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. I, No. 3, p. 14.
(142) Judd, U. S. Biol. Surv., Bull. No. 17, p. 96.
(143) Beal, Ibid., Bull. 13, pp. 12-22; Farmers' Bull. No. 54, p. 17.
(144) Forbes, Ill. St. Lab. Nat. Hist., Bull., Vol. I, No. 6, p. 13.
(145) Beal, U. S. Biol. Surv., Bull. 34, pp. 73-75. Farmers' Bull. No. 513, p. 5.
(146) McAtee, Food Habits of the Grosbeaks, U. S. Biol. Surv., Bull. No. 32; Our Grosbeaks and their value to Agriculture, Farmers' Bull. No. 456. Beal, U. S. Biol. Surv., Bull. No. 34, pp. 93-96.
(146-a) Aughey, First Rept. U. S. Entom. Comm., App. II, p. 28.
(147) Beal, U. S. Biol. Surv., Bull. 34, pp. 86-93.
(148) Judd, The Relation of Sparrows to Agriculture, U. S. Biol. Surv., Bull. No. 15, pp. 7, 11, 28-29; Birds as Weed Destroyers, U. S. Dept. Agric., Yearbook for 1898, p. 223. Farmers' Bull. No. 513, p. 4.
(149) Judd, Ibid., Bull. 15, p. 78. Weed, An Observation of the Feeding Habits of the Chipping Sparrow, N. Hamp. Coll., Agric. Experiment Sta., Bull. No. 55, pp. 101-110, 1898.
(150) Beal and McAtee, U. S. Dept. Agric., Farmers' Bull. No. 506, pp. 26-28.
(151) Beal, Farmers' Bull. No. 54, p. 28.

tree sparrow alone in 1 state (Iowa), in the cold half of the year, consumes 875 tons of weed seeds, enough to seed several counties. Aughey (152) found the stomachs of 31 species of this family to contain locusts and locust eggs, often in large numbers.

The house finch, so abundant in our western towns and cities, lives on weed seeds, and in Denver is found to feed its young chiefly on dandelion seeds (153).

The English sparrow is an interloper, whose habits are bad. It does very little good and drives out wrens, bluebirds, cuckoos and other birds. It takes few insects, few weed seeds, but feeds largely upon the waste of the streets in the cities, and upon grain in the country. One cuckoo contained more insects (in bulk) than 522 English sparrows. Only 14% of 2,500 English sparrow stomachs contained any insects. This sparrow should be prevented from increasing by destroying its nests, trapping, shooting or poisoning, care being taken not to destroy the useful native species (154).

Tangaridæ. The tanagers are highly insectivorous. Three May and August stomachs of the scarlet tanager contained insects exclusively (155). One scarlet tanager contained 37 locusts and a western tanager contained 13, with a large number of beetles (156). A remarkable flight of western tanagers in California in 1896 is said to have greatly damaged fruit (157), but unfortunately no stomachs were examined, so we have no knowledge of the proportions of various kinds of food they ate. Forty-six California stomachs taken from April to September contained insects 82%, fruit 18% (158). The young live at first exclusively upon insects (159).

Hirundinidæ. The swallows and martins feed almost exclusively upon flying insects, taken on the wing. As these birds are very active, requiring a large amount of food, and much of each insect is indigestible, the number they take is "not only beyond calculation, but almost beyond comprehension" (160).

One bank swallow contained 14 cotton boll weevils, a barn swallow contained 23 and a cliff swallow contained 47 (161). The food in a bird's stomach is often compressed into a hard mass, so that it is wonderful how much it will contain when distended and filled. The mass of insects contained in a swallow would, before compression, equal or exceed the bulk of the tiny body. Seven barn swallows contained an average of 20 locusts and 19 other insects; a violet-green swallow contained 23 locusts and 17 other insects; 8 cliff swallows averaged 30 locusts and 14 other insects; 4 bank

(152) Aughey, First Rept., U. S. Entom. Com., App. II, pp. 28-33.
(153) Bergtold, A Study of the House Finch, The Auk, Vol. XXX, pp. 47-48, 52, 1913.
(154) Barrows, et al., The English Sparrow (*Passer domesticus*) in North America, U. S. Div. Orn. & Mam., Bull. No. 1, 1889, 405 pages. Dearborn, The English Sparrow as a Pest, U. S. Dept. Agric., Farmers' Bull. No. 493; How to Destroy English Sparrows, Farmers' Bull. No. 383.
(155) Judd, U. S. Biol. Surv., Bull. No. 17, p. 98.
(156) Aughey, First Rept U. S. Entom. Com., App. II, p. 24.
(157) Emerson, The Condor, Vol. V, pp. 64-66.
(158) Beal, U. S. Biol. Surv., Bull. No. 30, p. 35.
(159) Judd, U. S. Dept. Agric., Yearbook for 1900, pp. 418-419.
(160) Beal, U S. Dept. Agric., Farmers' Bull. No. 54, p. 31; U. S. Biol. Surv., Bull. No. 30, p. 27. Henshaw, Value of Swallows as Insect Destroyers, U. S. Biol. Surv., Circular No. 56.
(161) Howell, U. S. Biol. Surv., Bull. No. 29, pp. 13-14.

swallows averaged 20 locusts and 21 other insects, and 10 purple martins averaged 26 locusts and 16 other insects (162).

When we consider that these figures represent single meals, and that each bird takes several meals daily throughout its life, and that these birds are very numerous, we may well agree with Beal's remark just quoted. Their nest parasites are not, as is popularly supposed, species which affect human beings (163). The bedbugs which swallows are supposed to harbor in their nests are not bedbugs, and not parasitic on man.

Bombycillidæ. The cedar waxwing is often called the cherry bird, but only 9 out of 152 stomachs (40 of which were taken in cherry season) contained cultivated cherries. About 74% of their food consists of the fruits of wild shrubs and trees (164).

Seven stomachs from a canker-infested orchard contained only canker worms (165). A Bohemian waxwing stomach from Nebraska in February contained "an immense number of locust eggs," and a cedar waxwing taken in June contained 17 locusts (166). The waxwings are seen in Colorado only in winter, when they are welcome visitors.

The Phainopepla of the Southwest catches insects on the wing in true flycatcher style, and also feeds extensively upon seeds and fruits, being particularly fond of the mistletoe (167). In Arizona I found them always in the mistletoe-infested mesquite trees.

Laniidæ. The shrikes are almost strictly carnivorous, and highly insectivorous, but also take many mice and a few birds. They are special enemies of the English sparrows, simply because these sparrows are more easily caught than most birds. The northern shrike, or butcher bird, visits the United States only in the winter season, and from October to April its food (155 stomachs) consists of mice and birds 60%, insects 40%, while in some places in March it is said to feed almost exclusively on field mice (168). The other shrikes, which are with us in the summer season, when insects are abundant, take a higher percentage of insects.

The California shrike, 124 stomachs, insects 83%, spiders and snails 2%, vertebrates 12% (169). The loggerhead shrike, 88 stomachs, insects 68%, spiders 4%, vertebrates 28% (170). One northern shrike contained 14 locusts, and 3 white-rumped shrikes averaged 32 locusts (171).

Vireonidæ. The vireos are almost exclusively insectivorous, from 91% to 98% of the food of the various species being insects and spiders (172). Three stomachs from a canker-infested orchard contained canker worms 44%,

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(162) Aughey, First Rept. U. S. Entom. Com., App. II, pp. 24-26.
(163) Henshaw, U. S. Biol. Surv., Circular No. 56, p. 2. Howell, Ibid., Bull. No. 29, pp. 12-13. Warren, Swallows and Bedbugs, The Condor, Vol. XV, pp. 14-16, 1913. Farmers' Bull. No. 513, p. 13.
(164) Beal, Farmers' Bull. No. 54, pp. 31-32. Judd, U. S. Biol Surv., Bull. No. 17, p. 99.
(165) Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. I, No. 6, p. 11.
(166) Aughey, First Rept. U. S. Entom. Com., App. II, p. 26.
(167) Coues, Birds of the Colorado Valley, pp. 477, 479.
(168) Judd, The Food of Shrikes, U. S. Biol. Surv., Bull. No. 9, pp. 15-26.
(169) Beal, U. S. Biol. Surv., Bull. No. 30, pp. 33-37.
(170) Beal and McAtee, Farmers' Bull. No. 506, pp. 29-31.
(171) Aughey, First Rept. U. S. Entom. Com., App. II, p. 28.
(172) Beal, U. S. Biol. Surv., Bull. 30, pp. 38-41. Judd, U. S. Biol. Surv., Bull. No. 17, p. 102

other caterpillars 35%, beetles 15% (173). Aughey found 6 species of vireos feeding extensively on locusts (174).

Mniotiltidæ. The wood warblers are almost exclusively insectivorous, their insect food varying with the different species from 85% to 99%, probably averaging 94%. They are special enemies of plant lice, scale insects and other minute pests which are overlooked by larger birds. They pass through our region in great numbers in migration, searching the bark, foliage and buds for insects, and several species remain through the summer. About 14 species have been investigated in some detail (175). In stomachs of 6 species from a canker-infested orchard two-thirds of the contents was canker worms (176). Aughey found 31 species of warblers feeding on locusts, many stomachs containing from 20 to 30 locusts, and some containing over 40, besides other insects (177).

Motacillidæ. The pipits feed upon small mollusks, crustaceans, insects and seeds. They may be seen tilting and bobbing along the streams and lakes at high altitudes in Colorado, where they nest, passing through the lowlands in migration. In Texas they feed to some extent on cotton boll weevils (178). Three Nebraska specimens taken in September averaged 48 locusts and 4 other insects each (179).

Cinclidæ. The water ouzel or dipper is one of the most interesting birds. It is a common resident along the mountain streams of the west. Though a passerine bird, it goes into the swift water in search of food with the ease of any aquatic bird. Its food consists to a large extent of aquatic insects. It is accused of catching young fish, and is often shot by fishermen for that reason, but, though captive specimens have fed on small fish fry, stomachs of wild specimens examined by Newstead contained no fish whatever, according to McAtee (180).

Mimidæ. Mockingbirds have been accused of doing damage to fruit in some places, notably Florida, Texas and New Mexico, but over most of their range they are not abundant enough to do much damage (181).

Thirty-three stomachs from Los Angeles contained an average of 23% insects, and 1 nestling contained grasshoppers and crickets 92% (182).

Two Illinois specimens contained grasshoppers and allies 60%, besides other insects (183).

Thrashers are more insectivorous than mockingbirds. Brown thrasher, 121 stomachs, Maine to Florida and west to Kansas, insects and allies 63%, fruit 8%, grain 3% (184). Four from a canker-infested orchard, insects

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(173) Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. I, No. 6, p. 10.
(174) Aughey, First Rept. U. S. Entom. Com., App. II, p. 27.
(175) Beal, Agric. Yearbook for 1904, p. 254; U. S. Biol. Surv., Bull. No. 30, pp. 42-46. Judd, U. S. Biol. Surv., Bull. No. 17, pp. 103-104.
(176) Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. 1, No. 6, p. 10.
(177) Aughey, First Rept. U. S. Entom. Com., App. II, pp. 19-24.
(178) Howell, U. S. Biol. Surv., Bull. No. 22, p. 16; No. 25, p. 14; No. 29, pp. 22-23.
(179) Aughey, First Rept. U. S. Entom. Com., App. II, p. 19.
(180) McAtee, Proc. Acad., Nat. Sci. Phila., Vol. LXIV, p. 323, 1912.
(181) Judd, Agric. Yearbook for 1895, pp. 415-416; U. S. Biol. Surv., Bull. No. 17, p. 104. Beal, U. S. Biol. Surv., Bull. No. 30, pp. 52-53. Cockerell, N. Mex. Agric. Exper. Sta., Bull. No. 37, p. 53, footnote.
(182) Beal, U. S. Biol. Surv., Bull. No. 30, pp. 52-54
(183) Forbes, Ill St. Lab. Nat. Hist., Bull. Vol. I, No. 3, p. 142.
(184) Judd, Agric. Yearbook for 1895, pp. 411-415; U. S. Biol. Surv., Bull. No. 17, pp. 105-106.

94%, 64 from elsewhere, insects 50% (185). The young are fed entirely on insects, parents having been observed to visit the young 286 times in one day, usually with food (186).

California thrasher, 82 stomachs, insects and allies 41%, fruit 18%, miscellaneous vegetation 26% (187). Probably other thrashers inhabiting the southwest, including the sage thrasher of Colorado and adjoining states, will be found very insectivorous.

Catbird, 213 stomachs, insects 44%, cultivated fruit 18%, wild fruits 36% (188). Insects 40% in 74 other stomachs (189). Fourteen from a canker-infested orchard contained insects 98%, myriapods 2% (190), and 5 from Nebraska averaged 30 locusts and 10 other insects (191).

Troglodytidæ. Wrens are from 93% to 100% insectivorous. They take many small species of insects overlooked by most other birds. They are among our most useful birds. Nine species have been investigated in considerable detail (192). It is estimated that a pair of house wrens carry to their young 1,000 insects daily (193). Aughey (194) found 7 species of wrens feeding locusts to their young.

Certhiidæ. Creepers are highly insectivorous, searching the bark of trees for insects, and their eggs and larvæ, and destroying many species which are great pests (195). Aughey (196) saw a pair carry 27 distinguishable locusts to their young in an hour. These birds are very useful.

Sittidæ. Nuthatches have much the same habits as creepers, and should be encouraged by every means. Four species have been studied in detail (197). Four stomachs of the slender-billed nuthatch averaged 23 locusts and 4 other insects each (198).

Paridæ. Chickadees and titmice have much the same habits as creepers and nuthatches—all guardians of our forest, shade and fruit trees. The number of insects, including plant lice, scale insects and insect eggs, they destroy is almost incredible. Even in winter one-half of their food is insects. Over 450 insect eggs were taken by 1 bird in 1 day and over 200 canker worm eggs were found in one stomach (199).

Chamaeidæ. Wren-tits have about the same habits as the Paridæ (200).

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(185) Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. I, No. 6, p. 7; No. 3, pp. 127-137.

(186) Judd, Food of Nestling Birds, Agric. Yearbook for 1900, p. 415. Gabrielson, A Study of the Home Life of the Brown Thrasher, Wilson Bulletin, Vol. XXIV, pp. 65-94, 1912.

(187) Beal, U. S. Biol. Surv., Bull. No. 30, p. 56.

(188) Beal, Farmers' Bull. No. 54, pp. 33-34.

(189) Judd, U. S. Biol. Surv., Bull. No. 17, pp. 104-105.

(190) Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. I, No. 6, pp. 6-7. See also No. 3, pp. 115-127.

(191) Aughey, First Rept. U. S. Entom. Com., App. II, p. 15.

(192) Beal, U. S. Biol. Surv., Bull. No. 30, pp. 57-66; Agric. Yearbook for 1903, p. 343. Judd, U S. Biol. Surv., Bull. No. 17, p. 107; Agric. Yearbook for 1895, pp. 416-418; Yearbook for 1900, pp. 413-415. Forbes, Ill. St. Lab. Hist., Bull. Vol. I, No. 6, pp. 8-9.

(193) Oldys, Agric. Yearbook for 1902, p. 216.

(194) Aughey, First Rept. U. S. Entom. Com., App. II, p. 18.

(195) Judd, U. S. Biol. Surv., Bull. 7, p. 107. Beal, Ibid., Bull. No. 30, p. 66; Agric. Yearbook for 1900, p. 296.

(196) Aughey, First Rept U. S. Entom. Com., App. II, p. 17.

(197) Judd, U. S. Biol. Surv. Bull. No. 17, p. 107; Beal, Ibid. Bull. No. 30, pp. 66-68.

(198) Aughey, First Rept. U. S. Entom. Com., App. II, p. 17.

(199) Beal, Agric. Yearbook for 1900, p. 206; Yearbook for 1904, p. 253; U. S. Biol. Surv., Bull. No. 30, pp. 70-80. Judd, U. S. Biol. Surv., Bull. No. 17, pp. 107-108. Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. I, No. 6, p. 8. Bailey, U. S. Biol. Surv., Bull. No. 22, p. 16. Howell, U. S. Biol. Surv., Bull. No. 25, p. 15; Bull. No. 29, p. 22. Weed, The Winter Food of the Chickadee, N. H. Coll. Agric. Exper. Sta., Bull. No. 54, pp. 85-96.

(200) Beal, U. S. Biol. Surv., Bull. No. 30, pp. 71-74.

Sylviidæ. The willow warbler is an Asiatic bird, reaching America only in Western Alaska. Our other American Sylviidæ are the kinglets and gnatcatchers, of each of which there are a number of species. They are very small birds, almost entirely insectivorous, living principally upon small insects, including plant lice and scale insects (201).

Aughey found both kinglets and gnatcatchers feeding on small locusts, one ruby-crowned kinglet containing 29 locusts (202), a surprising number for so small a bird.

Turdidæ. The food of the thrush family as a whole, according to Forbes, averages 61% insects, 1% spiders, 2% myriapods, 32% small fruits, 4% grain (203). The young of all members of this family are almost exclusively insectivorous.

Townsend's solitaire, found in our western mountains from Colorado to the Pacific, has been called the fly-catching thrush, because of its habit of catching insects on the wing, in true flycatcher style. It also feeds largely upon cedar berries and pinyon nuts (204).

Robins, where they are abundant and cherries are few, may congregate around the trees and destroy the fruit, but they prefer wild fruit, as do most fruit-eating birds. The planting of wild fruits about the orchards has been strongly recommended, as this keeps the birds away from the cultivated fruits when they wish fruit, yet retains their services in the destruction of the insects which would otherwise render fruit-growing more difficult. The destruction of olives in California by the robins when their natural food supply failed has already been mentioned. Under ordinary conditions, however, the robins and other thrushes are exceedingly useful. In 330 robin stomachs, animal matter was 42% (chiefly insects), vegetation 58% (wild fruit 47%) (205).

Many robins remain in our Colorado mountains in favorable localities through the winter, and feed chiefly on cedar berries.

Eastern bluebird, 108 stomachs, representing every month except January and November, insects 67%, spiders 8%, vegetation 13%, and 5 stomachs obtained in a canker-infested orchard contained insects 98% (206). In 205 other stomachs insects averaged 76% (207). In 187 stomachs of the western bluebird (Sialia m. occidentalis) insects formed 82% of the contents and vegetation 18% (largely elderberries), while in 14 mountain bluebirds the food was about the same (208).

(201) Beal, U. S. Biol. Surv., Bull. No. 30, pp. 81-86; Agric. Yearbook for 1904, p. 254. Beal and McAtee, Farmers' Bull. No. 506, pp. 34-35. Judd, U. S. Biol. Surv., Bull. No. 17, p. 108.

(202) Aughey, First Rept. U. S. Entom. Com., App. II, p. 16.

(203) Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. I, No. 3, pp. 139-145.

(204) Coues, Birds of the Northwest, pp. 93-96; Birds of the Colorado Valley, pp. 44-47. Cockerell, N. Mex. Agric. Exper. Sta., Bull. No. 37, p. 41.

(205) McAtee, Plants Useful to Attract Birds and Protect Fruit, U. S. Dept. Agric., Yearbook for 1909, pp. 185-196. Beal, How Birds Affect the Orchard, Yearbook for 1900, p. 303; The Relation of Birds to Fruit Growing in California, Yearbook for 1904, pp. 241-254; Birds of California in Relation to Fruit Growing, U. S. Biol. Surv., Bull. No. 30 and 34. Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. I, No. 3, pp. 88, 96-115; No. 6, pp. 5-6, 18-19. Judd, U S. Biol Surv., Bull. 17, pp. 108-109. Palmer, Agric. Yearbook for 1898, p. 261. Beal, Farmers' Bull. No. 54, p. 38.

(206) Forbes, Ill. St. Lab. Nat. Hist., Bull. Vol. I, No. 3, pp. 148-161; No. 6, p. 8.

(207) Beal, Farmers' Bull. No. 54, p. 39.

(208) Beal, U S. Biol. Surv., Bull. No. 30, pp. 97-100.

THE LITERATURE OF ECONOMIC ORNITHOLOGY

The literature of this subject is too voluminous to adequately review or analyze in a paper of this length. Items concerning the food habits of birds are to be found in most bird books, and scattered through a multitude of pamphlets, magazines, government reports, bulletins and circulars, the proceedings of learned societies, and reports of boards of agriculture and horticulture. Two most useful volumes are Forbush's Useful Birds and Their Protection, and Weed and Dearborn's Birds in their Relation to Man. Just as this report is ready for the press, two very important works have come to hand. One is Our Vanishing Wild Life, by Hornaday, published in New York. The other is an index to the United States Biological Survey papers on Economic Ornithology, by McAtee, published as a bulletin of the Survey. To the economic papers have been added a number of general reference books, such as Coues' Key, Ridgway's Manual, Chapman's Handbook and Color Key.

Very much the greater part of the serious work upon this subject has been done by the United States Department of Agriculture, the reports appearing in the Yearbooks, Farmers' Bulletins, and Bulletins and Circulars of the Biological Survey. The literature is so extensive that no attempt is made in the accompanying bibliography to list all papers of this nature. Weed and Dearborn's book contains a rather complete bibliography up to the date of its publication, ten years ago.

A very large part of the literature has been indexed in detail in the card catalogue and index of the University of Colorado Museum, which is available to students, and all inquiries relating to the subject will be answered, so far as reasonably possible, as part of the extension work of the institution.

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